MAY 23 1913

Engineering News

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NEW YORK, MAY 22, 1913

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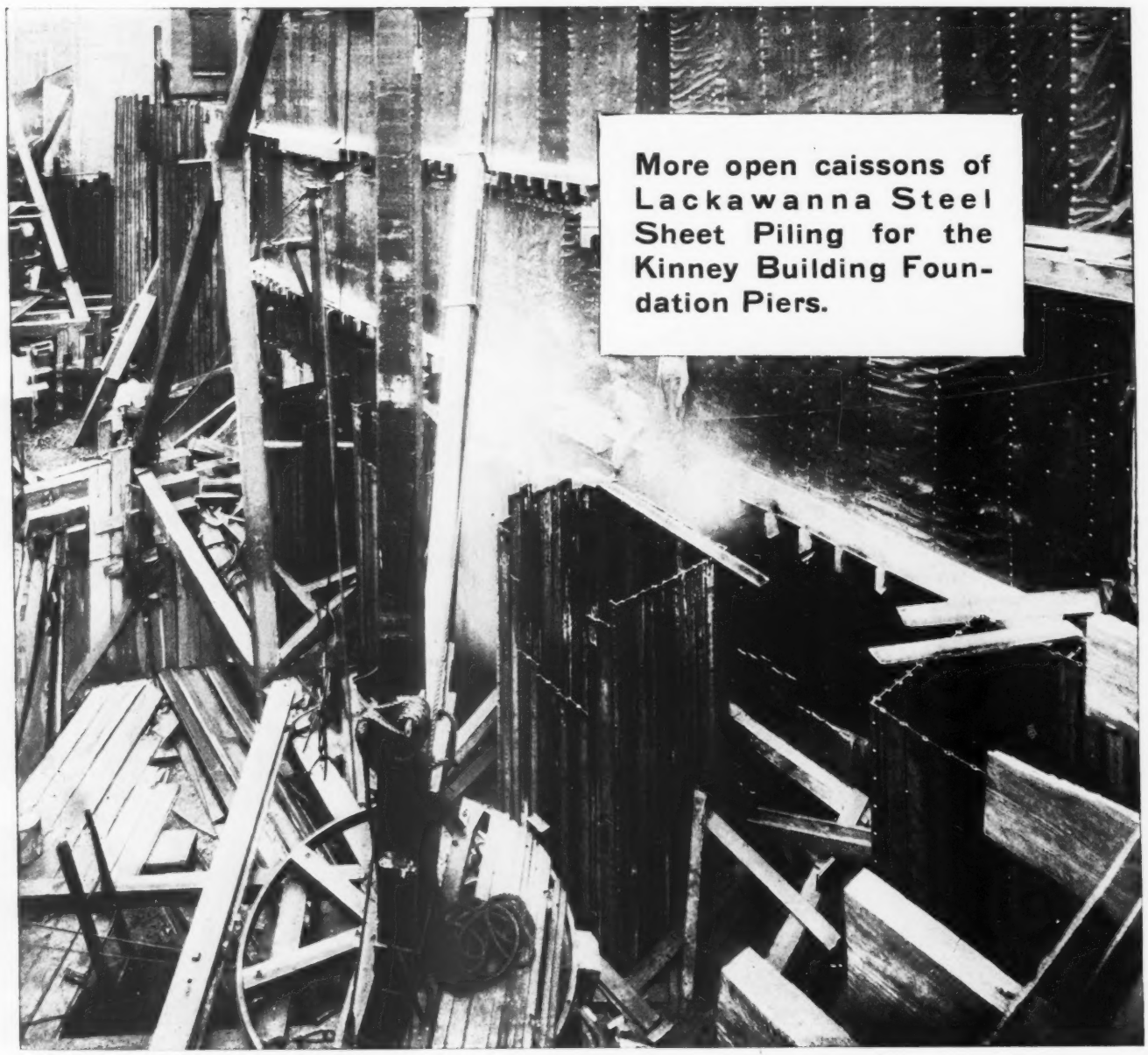

Above are shown assembled, seven of the rectangular open caissons of the Lackawanna Steel Sheet Piling which were driven for foundation work on the Kinney Building, Newark, as described in our advertisement last week.

The rectangular caissons for the foundation piers of this building extend 50 feet below curb and are mostly 6 x 6 to 6 x 9 feet although the largest measures 16 x 13 2-3 feet. After these caissons were driven and excavated they were braced with ranger frames of 6 x 6 and 8 x 8-inch timbers halved and bolted together at the corners, the frames being spaced 5 feet apart at top and 2 1-4 feet apart at bottom.

The performance of Lackawanna Steel Sheet Piling on this job throughout is well described by Mr. Louis L. Brown, General Superintendent of the Foundation Company of N. Y., who states:

"The Lackawanna Steel Piling which we used at the site of the Kinney Building, Newark, gave excellent satisfaction. We drove over 150 tons of this material from 20 to 30 feet deep, thru sand and hard clay mixed with gravel, to form the foundation piers. This piling we pulled and used over again two and three times."

Note especially after one installation the piling was good for much further service. This is good evidence of the splendid driving qualities, the great strength and the freedom from distortion of Lackawanna Steel Sheet Piling; also the capable way in which it was installed.

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Engineering News

CHARLES WHITING BAKER, *Editor*

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WHAT THE BUYER NEEDS TO KNOW

Number Twenty-one

Most people have an idea that the most successful writer of advertising is the man who has the greatest vocabulary at his command—such a man as in the days of the old-time circus made everything he wrote about "glittering, glorious, gorgeous."

As a matter of fact, the actual writing of an advertisement is the least important end of the business—it is in the planning that the ad man shows his real ability.

Modern advertising, the kind you are used to seeing in Engineering News, for instance, is nothing more nor less than salesmanship-on-paper. The good appearance of the salesman, the clarity of diction, the sincerity of appeal, all are found in the modern advertisement just the same as in the modern salesman.

The simile is carried still further in the way the advertisement is prepared. Before a salesman calls on you, he has "sized up" your needs, for he knows he must offer you goods that you will recognize as being exactly the things you need. So it is with the advertising man.

He is employed, for instance, to write advertisements for piling. He may have been brought up in a construction company, may know a lot about piling, yet, in order to be sure of the power of appeal of his ads, he conducts an investigation. In some cases these preliminary studies occupy a long time before a line of copy is written.

The wisdom of this modern sort of ad writing has been demonstrated on many occasions.

In one case, a manufacturer of a certain machine had been writing his own copy. He was admittedly a most successful salesman, he knew his product thoroughly, yet his ads did not sell any machines. When an advertising man took over the problem and investigated it, he found that the ads were being read but were not believed. Years before a somewhat similar appliance had been put on the market with a fault in its construction. The advertised machine apparently had the same fault, so the readers quite properly set it down as a fraud.

But it was not a fraud—the fault of the old machine had been overcome in the new. So the ad man explained this in his copy and told, frankly, just why it was so. The result was that the readers recognized the correctness of the ad man's arguments, bought the machine and found that they had been wasting double the cost of the production of certain articles for many years.

The point is just here. The advertiser gets benefit from the ad man's investigation, certainly, but the man advertised to gets much more, for the benefit to the advertiser sometimes ends with a sale while yours goes on and on in costs cut, efficiency boosted and capacity for work enhanced.

Engineering News

VOLUME 69 MAY 22, 1913 NUMBER 21

The Hydro-Electric Development of the Braden Copper Co.

By C. G. Newton*

The Braden Copper Co., of Rancagua, Chile, built its hydro-electric plant on the Cachapoal River, in the Province of Colchagua, to furnish electric power for mining, ore hauling and for the concentrating and smelting establishment, etc.

Water is taken from the Cachapoal River, delivered through 7.9 miles of canal to the station forebay, and finally is passed through three 4-ft. steel pipe lines, under 450 ft. total head. The present installation consists of three 2000-kv.-a., three-phase, 2300-volt, 60-cycle, 600-r.p.m. alternators, directly connected to Francis-type turbines. There are two 100-kw., 125-volt, 720-r.p.m., direct-current exciters, direct connected to impulse wheels, and a 40-kw., 125-volt, 690-r.p.m. motor generator also direct connected to an impulse wheel.

The current is stepped up from 2300 to 33,000 volts, and transmitted 15.5 miles on a steel-tower transmission line to the mill substation, where it is stepped down to 2200 and 550 volts for distribution.

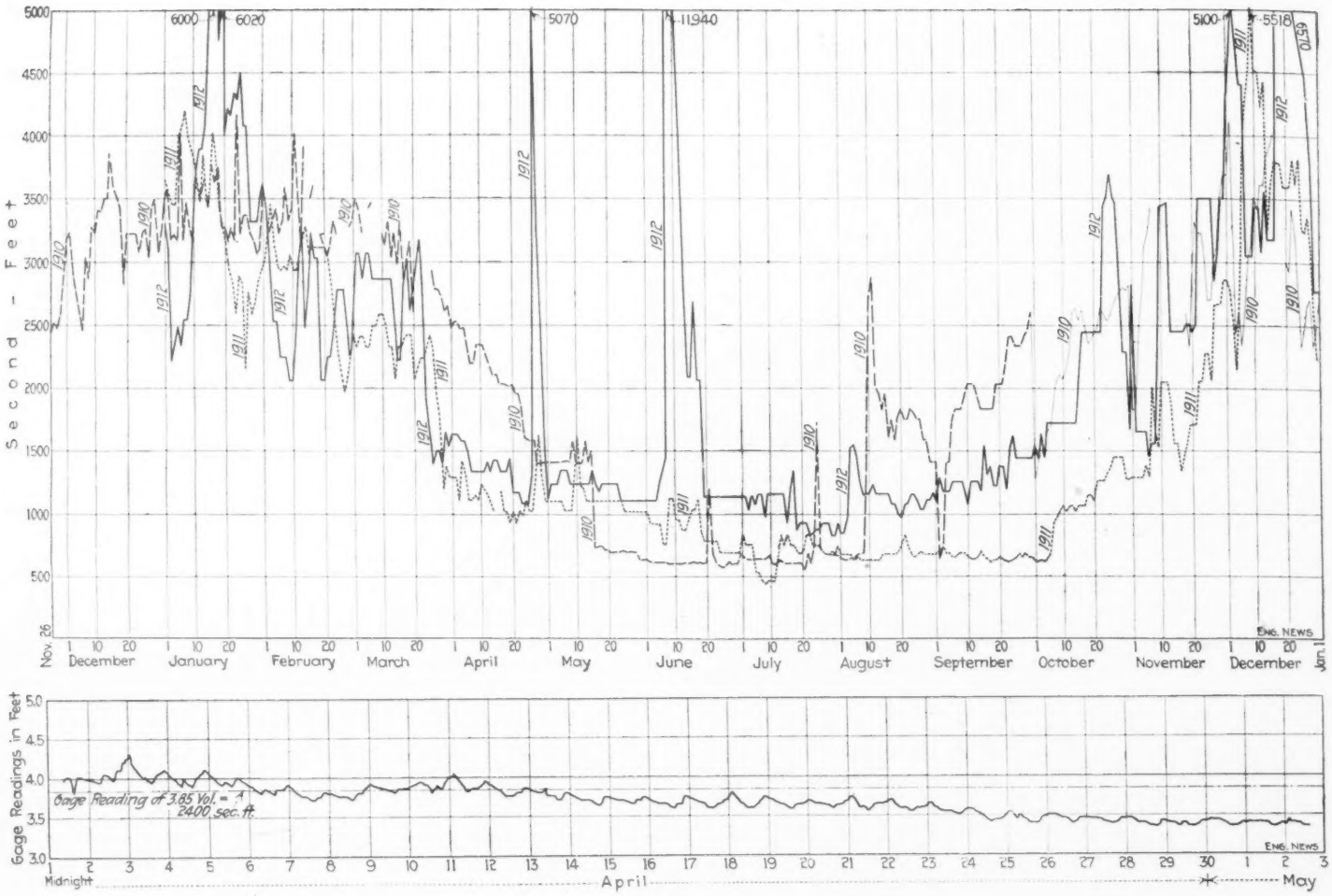
Dam and Headworks of the Braden Copper Co., Rancagua, Chile

Cachapoal River

The Cachapoal River has its source in the Andean Cordillera, which rises in this locality to 13,000 or 14,000 ft. The water supply comes from snow fields and, on most of the tributaries, from glaciers, some of them extensive. This source is apparent at the first inspection, as at all times the river carries a fine white sediment which requires days to settle, and which gives the water an appearance very similar to that of the glacier-fed rivers of Alaska.

The annual rainfall is from 15 to 27 in., practically all in the winter months of June to September. But the high-water period of the river is in the summer, December and January, when the flow of the Cachapoal amounts to from 5000 to 6000 sec.ft. In the winter low-water period, June and July, the flow falls to a minimum of about 500 sec.ft. At intervals of a few years, however, extraordinary floods occur, due to continued warm winds and rain on the snow fields. Last winter,

*Chief Engineer and Superintendent of Hydro-electric Construction, Braden Copper Co., Rancagua, Chile, S. A.



FIGS. 2 AND 3. HYDROGRAPHS OF THE CACHAPOAL RIVER

in June, 1912, a flood lasting a few hours only, passed 12,000 sec.ft. over the Braden dam and, as shown by driftwood and local records, a 100,000-sec.ft. flood passed the power-plant site a few years ago.

The river, having a slope of 60 ft. to the mile, is continually bringing down rocks and gravel of all sizes up to 10 or 12 in. in diameter, and also carries, in the summer high-water season, a considerable quantity of coarse, sharp sand, of first-class quality for concrete. It was necessary to make arrangements in the canal to eliminate these rocks and sands, otherwise the canal would have been rapidly filled up.

CANAL CONSTRUCTION

The canal was designed for a net capacity of 500 sec. ft. after wasting part of the water for sluicing out the rocks and sand and making allowance for filling up, vegetation, etc.

The intake works of the canal (see figure on preceding page) consists of a pudding-stone concrete dam, raised to a height of 12 ft. above the river bed and given an ogee curve on the apron. It has a reinforced-concrete intake structure with four steel inlet gates worked by hand gearing. This gearing is housed so as to not be carried away by floods. All material for the canal had to be hauled by ox-cart 25 miles from the railroad.

ROCK AND SAND OUTLETS—For a distance of 1000 ft. below the intake, the canal has a grade of 0.003($\frac{3}{10}$%), an average velocity of 8 ft. per sec. and a capacity of 1000 sec.ft. This was to allow for sufficient water for wastage at the rock outlet and sand-settling tank. This headrace is lined with masonry where necessary. At the end of the 1000 ft. headrace comes the rock outlet sluice (Fig. 4), regulated by two steel gates, set in concrete in the wall of the canal, one of which is always open 2 or 3 ft. The rocks are carried along by the swift current until they come to the rock outlet, where there is a drop of 2 ft. in the bottom of the canal, from whence they are discharged into the river.

One hundred feet below the rock outlet is the sand settling tank (Fig. 5) where the canal widens to 50 ft., for a length of 84 ft., and the average velocity decreases

FIG. 4. ROCK-OUTLET SLUICE, BRADEN CANAL

SOME DETERMINATIONS OF THE VALUE OF THE COEFFICIENT [n] IN KUTTER'S FORMULA FOR THE FLOW OF WATER IN CANALS: MADE FROM CAREFUL CURRENT-METER DETERMINATIONS OF THE FLOW IN BRADEN CANAL

Condition of wetted surface	Depth of Water, ft.	Top Widtn of Water, ft.	Bottom Width of Canal, ft.	Grade of Canal	Volume of Water, ft.-sec.	Value of "n"
Sides are masonry walls with stones rounded, greatest projection of stones is 3 in. beyond joints. Bottom is fairly smooth cement over masonry floor	7.4	18.0	10.2	0.00237	801.7	0.023
Sides are clay with few smooth rocks. Bottom half covered with rocks 3 to 8 in. diam. Sides and bottom slightly uneven	6.0	17.48	11.48	0.0011	481.5	0.020
	7.0	16.39	11.16	0.0010	452.4	0.025
Loose Rock. Rock points project 3 to 6 in	5.0	13.88	9.56	0.0011	277.7	0.021
Section in medium hard rock. Few points project 3 to 12 in. Smooth section for rock	5.5	17.5	7.0	0.0010	306.6	0.022
	6.0	19.0	7.15	0.00092	292.2	0.026
Section in "adobe ground," sides water cut near water surface. In bottom some coarse gravel mixed with adobe	5.0	16.45	7.25	0.0010	255.7	0.022
Section in adobe ground with about 10% gravel. Sides are even and uncut	5.0	15.65	10.25	0.0011	230.7	0.029
Gravel section with about 30% earth. Sides are even and uncut						
Rock section. Rock is seamy and points project 3 to 12 in. Some holes in sides 12 to 15 in. deep						

from 8 to 1½ ft. per sec., thus dropping all the coarse sand, which is carried out through the bottom holes by a portion of the water. Below the sand tank, the water again acquires a velocity of 4½ ft. per sec., so that all sediment that is carried through the tank by a 1½-ft.

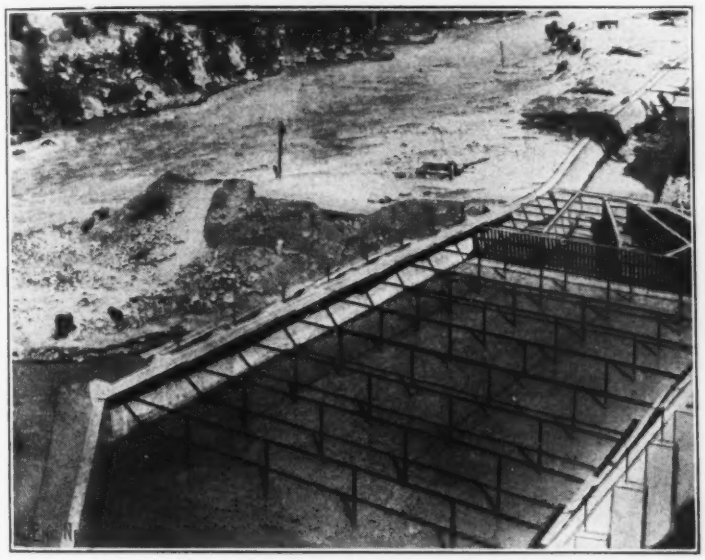


FIG. 5. SAND TANK, BRADEN CANAL

per sec. velocity is easily carried along the canal with no danger of deposition below.

The construction of the sand tank is shown by Fig. 6. There are 45 holes in the flat concrete bottom; they are arranged in nine rows of five each, which open into nine concrete pipes lined with old railroad rails, and tapered diverging towards the outlet, so as to maintain approximately the same velocity at all sections. These 45 holes are opened by horizontal steel-plate gates, sliding in cast-iron guides, and worked by hand wheels at the top of the side walls, which hand wheels drive bevel gears attached to the gate stems. The outlet holes are generally wide open, carrying out the deposited sand and a portion of the water flowing in.

The sand tank requires little attendance, and has worked very effectively for the first 18 months of operation, no sediment having settled in the canal, whereas the local irrigation canals, using the same water, have to be laid off in the winter in order to shovel out the sand which deposits in them.

BELOW THE SAND TANK—The canal and flumes (of which there are six and the longest is 730 ft.) have a grade of 0.001 ($\frac{1}{10}$%). The tunnels (of which there are four and the longest is 1485 ft.) have a grade of 0.0034.

The flumes (Fig. 7) have a bracing of tie rods, one on each side between the cap and sill of the collar, which serve the double purpose of eliminating racking and of preventing the 10x10-in. posts from rising out of the daps in the sills, something which frequently occurs if nothing is done to obviate it.

The canal is generally in tight gravel, with some adobe ground, some volcanic hardpan, locally called "tosca," and some solid rock. Careful flow-meter measurements were made to deduce (n) for Kutter's formula as shown in the accompanying table. All the canal excavation, which was hand work, was done by contracts let to small gangs of Chilian peons, 10 or 15 men to the gang. The junction of the canal with the flumes is made by a masonry collar, well winged into the earth. The tunnels are in solid rock, disintegrated rock and

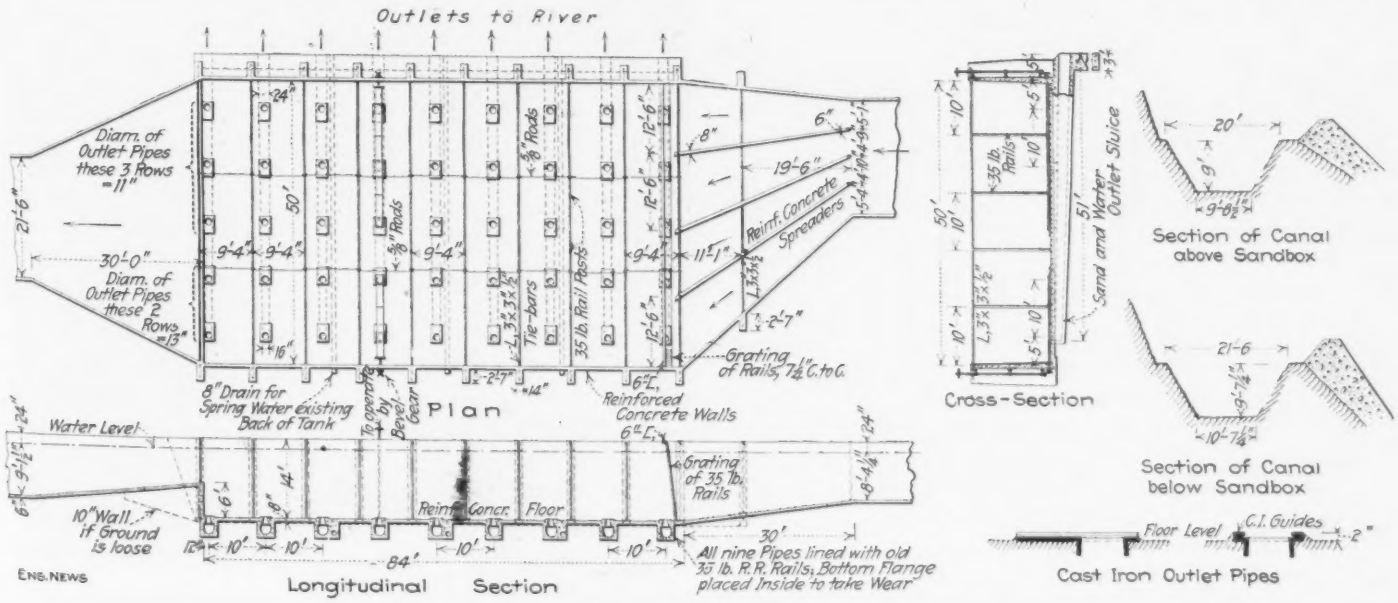


FIG. 6. DETAILS OF SAND-SETTLING TANK

gravel. About a third the total length of tunnels had to be timbered. Arched timber sets were used lagged outside a flume box was placed inside, similar to the standard flume type noted.
made with a 6-ft. drop in the bottom of the canal, 15 ft. long. Each is discharged by four steel gates set in reinforced concrete, and worked by hand gearing. One is shown in Fig. 9.

Besides the gate spillways there is just above the forebay, an over-top spillway, or waste wier, with a crest 76 ft. long and capable of passing the full capacity of the canal.

The forebay is widened to about 40 ft. and deepened to 18 ft., for a length of 100 feet, to give capacity for a

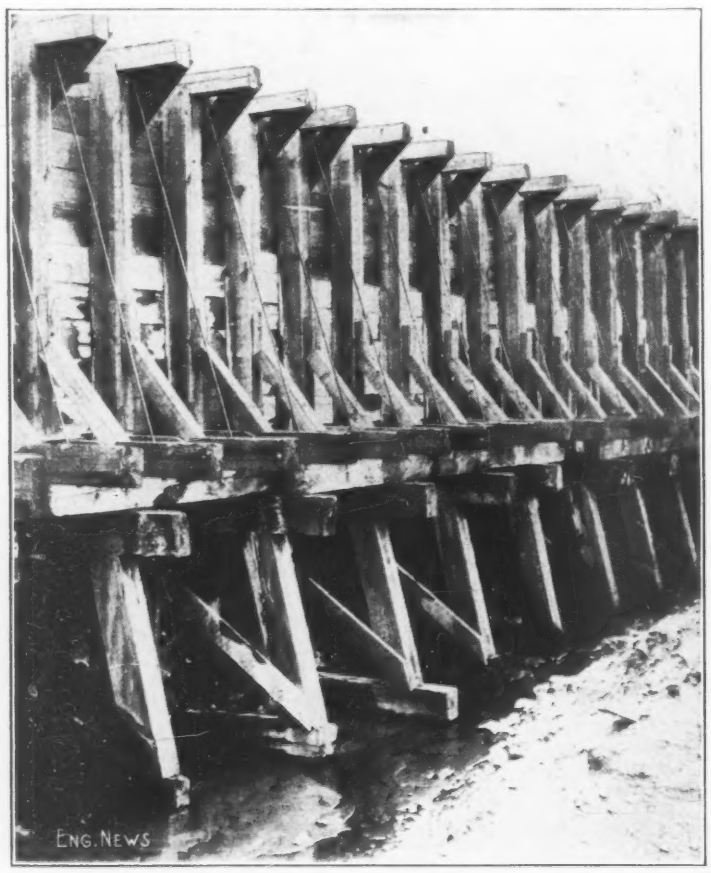


FIG. 7. EXTERIOR OF BRADEN FLUME
(Showing tie rods and corner braces.)

small peak load. More is not required since most of the load is steady.

The forebay dam is masonry, in which are set the pipe entrances. These entrances are closed by flap gates worked by winches. Six-inch bypass pipes serve to fill the power pipes.

POWER PLANT

The steel pipe lines are approximately 1080 ft. long, with a total head, forebay to river, of 450 ft. They are set in masonry anchors at about 200 ft. intervals, and between anchors are bedded in gravel. Each pipe has an expansion joint just outside the forebay wall

The power-house building (Fig. 10) has concrete foundations carried well below river-bed level, the outside wall being anchored also by railroad-rail piles driven into the bed of the river. The outside wall is 25 ft. high to floor level, which is placed one foot above the highest flood level on record. The wall is pierced with weep holes, to prevent any hydraulic pressure, due to a high flood, from acting against the inside of the wall An inside toe at the foot of the wall, about 7 ft. wide, of concrete reinforced with rails, which carries the

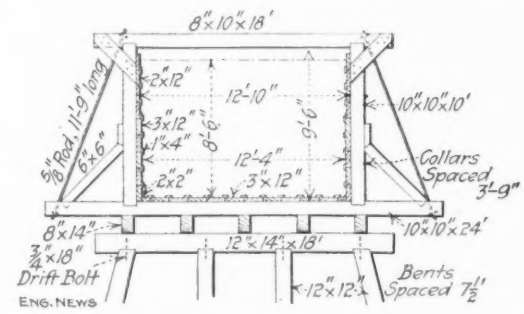


FIG. 8. CROSS-SECTION OF BRADEN FLUME

weight of the gravel filling inside the wall, also adds to the stability of the wall.

The building frame is steel with corrugated-iron walls, wooden-sheeting, hand composition roof, concrete floors, and reinforced-concrete walls and barriers.

The water is controlled by an hydraulic operated valve, at the entrance to the turbine. The turbines are the inward-flow reaction type, with double discharge into twin draft tubes—what is usually called the "high-head Francis" type. It is probable that the conditions at this plant are not such as to insure the most satisfactory working or develop the very best efficiency of this type of turbine. The governors are of self-contained oil-pressure type, belt driven from the turbine shaft.

The transformers are set in banks of three, and are single-phase, oil-insulated, water-cooled types enclosed in concrete fireproof cells. The switching layout of the station is shown by the skeleton diagram (Fig. 11).

The transmission line is protected by choke coils in the building and by electrolytic-type of lightning arrestors outside. Electric storms are few in this part of the country, but seem to be increasing in frequency and violence. All busbars and leads inside the building are

FIG. 9. GATE SPILLWAY IN BRADEN CANAL

shrouded in concrete barriers to make them foolproof and fireproof. They are not quite foolproof, however, as during the finish of construction, and while the first unit was in operation, one Chilian workman struck the high-tension bus a glancing blow with a nail held in his hand; later on, another one held his long whiskers up to the same bus "to see if it was hot." Both satisfied their curiosity, though neither was killed.

Transmission Line

The transmission-line towers are three-legged with compression members of old 35-lb. rails and round-iron tie rods. Towers are made standard from the top down, and cut off to fit the side hill. The legs enter the ground 6 ft., the bottom 2 ft. being set in concrete. The average span is 543 ft., and the longest span 917 ft., while the average height of tower is 57 ft. above the ground. The towers were made by the company, and cost about the same as structural-steel towers of the same height, made in the United States, would have cost delivered on the ground. But the erection was more expensive than that of the usual structural-steel towers on account of the greater comparative weight of the railroad-steel members.

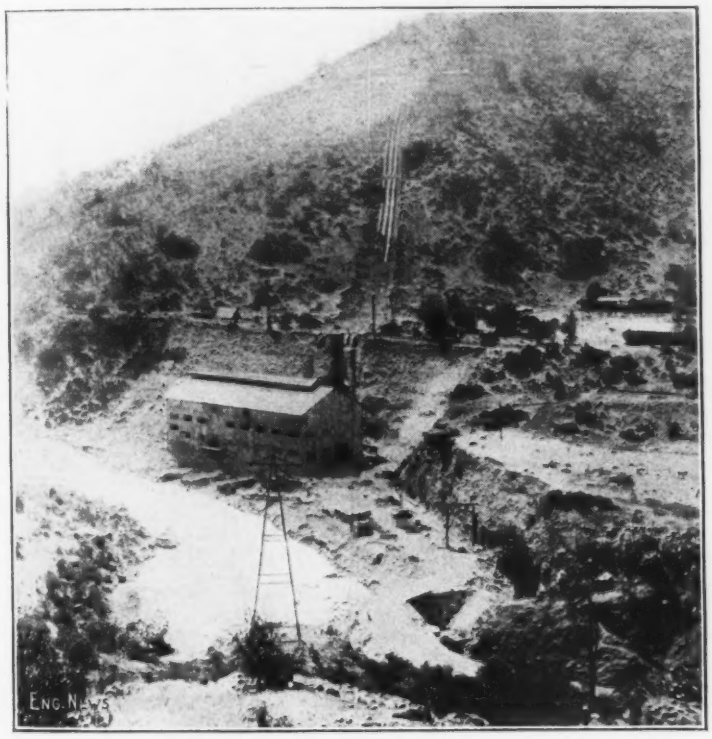


Fig. 10. Power Station and Pipe Lines, Braden Copper Co.

The insulators are a suspension type, arranged for simple suspension on level ground or where the inclination is equal on both sides, and for dead-end or "strain" construction at the brow of a hill and at angle towers. All angle towers are guyed both ways in the line of the strain.

The line is arranged for two circuits, one on each side of the tower, each in a vertical plane, with cables spaced 5 ft. apart. One circuit only, of No. 2 stranded copper cable, is in place at present. The line is transposed six times in the 15.5 miles. In addition to the lightning arrestors at the power house and substation, the line is further protected by a ground cable of 3/8-in. galvanized steel, which is clamped at the heads of the towers, and is grounded by a copper wire and plate to the moist earth of creeks or springs at seven places in the length of the line.

The line runs from an elevation of 2600 ft. above sea level at the power house, to 6200 ft. at the substation. It follows approximately the line of the Company's railroad, on account of ease of construction, although the distance is somewhat increased over a straight line. A perfectly straight line would have been impracticable in any case, on account of the rugged mountainous character of the intervening country.

Substation

The substation is built with a steel frame, and concrete floors and barriers, similar to the power house. The current is stepped down to 2200 and 550 volts for secondaries running to the mining, milling and smelting establishments.

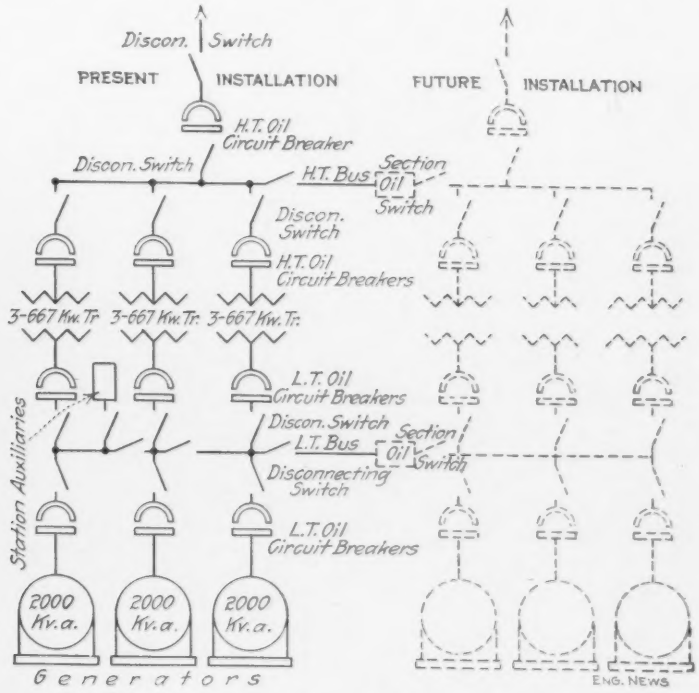


Fig. 11. Switching Diagram of Braden Power Development

Construction Notes

The bulk of the work on the plant was done by Chilian peons, helped out by a few Spanish, English, and other European workmen. The Chilians are hard workers if they have the right handling, and are at their best when a contract on earthwork or masonry is given to a small gang of 10 or 15 men who know each other, and who have an accepted leader in the gang. On rough timber work they are not so good, as not many are accustomed to it, most of their carpenters being "joiners," used rather to making furniture by hand and not much else.

As machinists, they are poor and unreliable, probably due to the lack of proper training in good shops, which are few in Chile.

All the construction work except the contract work of excavation and masonry and contract oxcart and mule freighting, had to be done by day workmen under foreign foreman (generally English, American or Scandi-

navian), as the Chilian workmen and contractors were not familiar enough with such work to be trusted with it.

The following unit costs (U. S. currency) of construction work may prove interesting:

Canal excavation per cubic yard	$0.407
Canal excavation per linear foot of canal	6.33
Masonry construction per cubic yard	6.64
Concrete construction per cubic yard	27.04
Canal concrete lining 6 in. thick per square yard	2.39
Canal masonry lining 1 ft. thick per square yard	1.63
Flume construction complete per linear foot	33.91
Flue construction complete per M. ft. b.m.	85.68
Tunnel excavation per cubic yard	4.96
Tunnel excavation per linear foot	24.04
Steel pipe lines 48-in. diam. complete per linear foot	22.94
Power-house steel work erected per ton	148.17
Power-house building complete per square foot of floor space	19.53
Power-house machinery and electrical equipment complete per generated horsepower	18.88
Substation building per square foot	13.80
Substation equipment per horsepower output	5.71
Freighting by oxcart per ton mile	0.36

The location survey of the plant was begun in November, 1909, construction commenced in January, 1910,

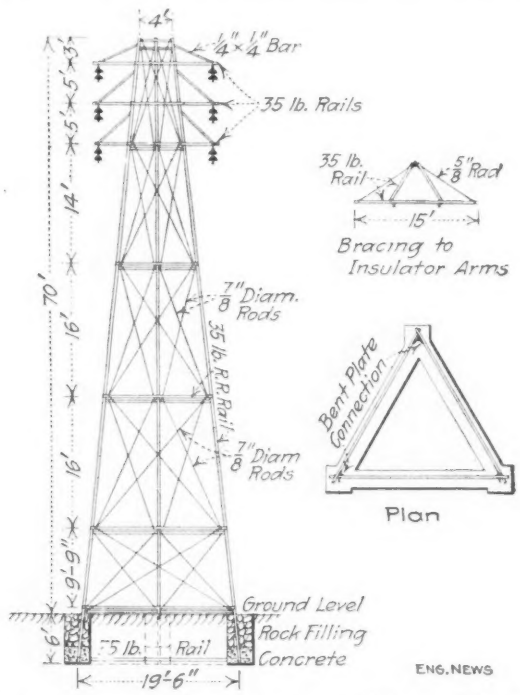


FIG. 12. TRIPOD TRANSMISSION TOWER MADE OF OLD RAILS AND TIE RODS

and the first unit began to deliver power at the works in August, 1911.

R. T. White is General Manager of the Braden Copper Co., and Pope Yeatman, Consulting Engineer. The plant above described was designed and built under the writer's direction as Chief Engineer.

⁂

To Secure Light-Weight Reciprocating Parts in high-speed gasoline engines for automobiles, aëroplanes, etc., experiments are being made in the use of magnalium, an alloy of aluminum and magnesium, with the very low specific gravity of 2.5, less than that of aluminum. According to a paper by Morris R. Machol, read recently before the Society of Automobile Engineers, in New York, magnalium pistons have been successfully used in such engines, although the metal melts at only 1256° F. As the thermal conductivity of magnalium is fourteen times as great as that of iron, the heat is transmitted much more rapidly from the surface of the piston exposed to the heat of combustion to the water-jacketed cylinder wall. Magnalium has also been used for engine connecting rods. An advantage of the metal for both these purposes is that it is an excellent bearing metal. It is claimed to have a much lower coefficient of friction than either babbitt or bronze. A 14-cylinder, 80-hp. aëroplane engine now under construction has cylinders 3½x4 in. made of steel tubing. Magnalium is used for cylinder heads, pistons, connecting rods, push rods and valve guides and for the crank case. The complete motor will weigh less than 200 lb.

Reinforced-Concrete Trolley Poles in Syracuse and Utica

Three years' trial use of reinforced-concrete poles for trolley and railway transmission-line work in Syracuse and Utica has proved so satisfactory that the New York State Railways Co. has installed at its Eastwood yard a plant having a capacity of 10 to 15 poles a day, according to an article in the *Electric Railway Journal*, Mar. 15, 1913.

The yard is 50x300 ft. and is at one end of the material-receiving yard adjacent to a steam railroad. A 36-ft. span gantry crane, equipped with a 3-ton hoist, travels on rails the length of the yard to handle the concrete hopper and the poles.

Four standard sizes are made at present: (1) One with a 7-in. top, 30 ft. long, the standard trolley pole for city construction with either brackets or spans; (2) with 7-in. top, 35 ft. long, for interurban work; (3) with 8-in. top, 30 ft. long, for heavy city construction; (4) with 8-in. top, 45 ft. long, for feeder lines. The reinforcement is as shown in Fig. 1, and has been designed for maximum economy of steel by calculation and test. The standard pole for city construction has four ⅝-in.x29-ft. 6-in., four ½-in.x23-ft., four ½-in.x16-ft., and four ½-in.x8-ft. twisted steel rods laid about one inch from the concrete surface as shown in Fig. 1. Poles with 8-in. tops have the same arrangement of rods but all of ⅝-in. size, and the long poles merely have the rods lengthened at the top.

The poles are cast in forms, such as are shown in Fig. 2, made from three 2-in. Georgia-pine planks. The side planks are clamped in position by notched 2x4-in. pieces above and below. Chamfered corners are provided by triangular corner strips. Pieces of round iron are inserted where holes in the pole are needed and gains for crossarms are made by blocks nailed to the form at proper places.

The concrete is hand mixed and is carried in a one-ton hopper from form to form. The following specifications are followed:

SPECIFICATIONS FOR FORMS:

This form to be built of hard pine and chamfer strips to be put on with screws and finishing nails Side cleats to be bolted.

Chamfer strips to be placed on side sections of form. Gain block placed on bottom section: if chamfer strips come higher than gain block two small strips are to be placed on gain block as shown.

Forms should be oiled before using inside and out with raw linseed oil. Holes through pole for bolts made by blank bolts, same size as hole, embedded in concrete through form and pulled out two days after casting pole.

Bolts should be loosened by turning slightly six hours after pole is cast.

INSTRUCTIONS FOR CASTING CONCRETE POLES:

Before casting poles, oil form inside with a mixture of one part black oil and one part gasoline. This oiling to be done immediately before casting pole.

The concrete mixture to be formed from one part cement, two parts sand and two parts stone, measurement to be made by volume.

All stone used to be clean and free from loam or dirt. Thoroughly wet the stone in the pile before mixing.

Sand to be free from loam or dirt. Place the proper amount of sand on the mixing board and spread out to a thickness of 4 in. On this sand place the cement and turn both three times, after which apply the water and turn so that the mass is entirely wet. Spread out this mortar again in a 4-in. layer and dump the stone in another layer on top. Turn the mortar and stone until mortar and stone are thoroughly intermixed. The concrete mixture must not be left

on the board long enough to require retempering, but should be placed in the forms at once.

In placing the reinforcing rods great care must be used properly to locate the same and maintain in the proper position.

The time of removing of side forms and moving of pole to storage will vary with the weather, but in no case shall a pole be lifted until 96 hours have elapsed after casting. After removal from the forms the pole shall be painted with a mixture of one part cement and one part sand, the pole being wet before the application of this paint.

Remember that a crack formed in a pole by handling too green cannot be healed.

In the storage and shipping of poles 2-in. cleats must be placed between the separate horizontal layers of poles to allow attachment of clamps for handling.

The cost of the standard pole is from $9.50 to $12 each, with stone and sand at $1 per cu.yd., cement at $1.10 per bbl., and labor at 16 to 17½c. per hr., but not including overhead charges.

In the spring of 1911, tests were made on the 30-ft. type with 6-in. top, which was on trial. Two poles were

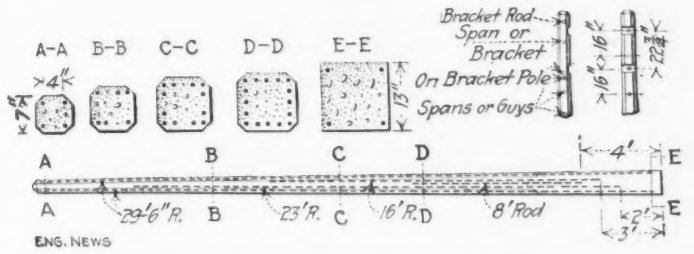


FIG. 1. STANDARD REINFORCED-CONCRETE TROLLEY POLES OF THE NEW YORK STATE RAILWAYS CO.

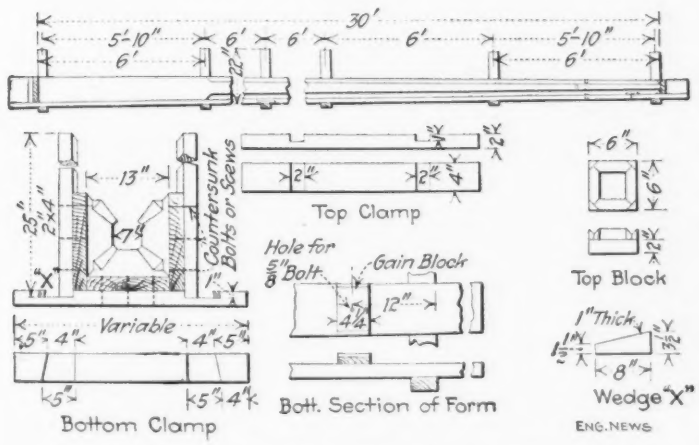


FIG. 2. FORMS FOR TROLLEY POLES; NEW YORK STATE RAILWAYS CO.

set 38 ft. apart with a 15-in. rake. A ring of concrete was placed at the butt of each pole on the ground line. A span wire was stretched between the two tops and pulled up to a tension of 1100 lb., which produced a deflection of 3 in. The span wire was then loaded at points corresponding to the center line of two tracks, to 1332 lb. On removal of this load a permanent set of 2¾ in. remained in the pole. The same load was again applied and the span wire was cut at the center, when the pole returned practically to its original position. Later tests with the 7-in. top pole, which was finally adopted, showed greater strength; this pole had a greater area of steel at the ground line where the old design showed signs of failure.

It was found that success with these poles depended on the facilities for erecting. At first a portable derrick made from an old road scraper was used, but later a special derrick wagon was built.

Hydraulic Excavation on Panama Canal Slides*

The Cucaracha slide and the slide immediately north of Gold Hill, on the east bank of the canal, have broken back so far from the canal center line that the slope of the earth at their outer edges is away from the prism. Gold Hill, which is between the two slides, rises to 652 ft. above sea level and presents a sheer face of dark, hard rock rising to 482 ft. above the canal bottom. This mass stands as firm as Gibraltar, while the soft material flanking it at the crest of the continental divide is involved in slides which are exceeded in volume only by the slide diagonally opposite, on the west bank at Culebra. No other breaks reach so high above the canal bottom.

Equipment used in the hydraulic excavation south of Miraflores locks is being installed for the purpose of sluicing material from the tops of the slides back into the valley toward which the earth slopes on the two sides and at the rear of Gold Hill. The surface over which it is proposed to waste the spoil is about 240 ft. above sea level. The construction of flumes on grades of 4.6 and 5% will allow the sluicing of earth down to an elevation of 330 ft. above sea level.

Sluicing will begin at the top of the slide to the north of Gold Hill. Under the original survey, it was estimated that 1,400,000 cu.yd. were to be removed from this area, but a later break of the earth, farther back, has rendered estimates of the extent of operations only approximate.

It is estimated that between 1,000,000 and 1,500,000 cu.yd. can be removed economically by hydraulic sluicing in the Cucaracha territory, in addition to that which will be sluiced down the slide into the canal, to be removed later by suction dredges. The material to be excavated is mostly soft earth, and includes a dump made from the French excavation.

Water will be supplied by damming the upper Obispo River and several of its tributaries, draining a watershed with a total area of 4.1 sq.mi. This will be accomplished without difficulty, because the course of the stream is already crossed by an American dump through which 20-in. pipes have been laid for drainage. The water can be dammed by merely raising the pipe intakes with vertical elbows.

Foundations and retaining walls for the pumping station have been built of concrete at a point near the relocated line of the Panama R.R., about four miles above Pedro Miguel, and 3000 ft. east of the canal, opposite Culebra.

The station is to be equipped with half of the Agua Dulce pumping plant, consisting of two 24-in. triple-expansion horizontal pumping engines and 500-hp. boilers.

Each unit was originally rated to deliver 7500 gal. per min. at 150 lb. pressure. In their worn condition, however, and in forcing water against a 100-ft. rise to the level of excavation, they will be counted on to furnish water at the monitors under pressure of only 80 to 85 lb. per sq.in.

The pipe line from the station to the top of the slide on the north side of Gold Hill is approximately a mile in length. When the excavation is extended toward the Cucaracha slide an electrically driven "booster" pump is to be installed on the northeast side of Gold Hill at elevation 425 ft., 200 ft. above the pumping station. The pipe-line approach to the Cucaracha slide will be made through a saddle between the main part of Gold Hill and an adjacent knob.

The pumping plant and machine shop are close to a spur extending from the relocated Panama R.R., and additional tracks render the area accessible to trains and locomotive cranes for the handling of heavy parts.

The foundation for a fuel-oil tank to hold 1000 bbl. is laid near the station.

It is expected that sluicing will begin about the middle of June, by the time the rainy season flow of the streams has accumulated a sufficient reserve supply of water at the pumping plant.

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The Contract for Supply of Crude Petroleum by the Union Oil Co., of California, to the Isthmian Canal Commission and the Panama R.R. has been extended until June 30, 1914. This company has supplied crude oil since August, 1907, and in November of that year completed a pipeline across the Isthmus. At first oil was delivered at the rate of 90c. per barrel, but since 1909 a price of $1.10 has been obtained. The maximum amount that can be purchased in any one month at present is 100,000 bbl. The total annual barrels jumped from 6919 in 1907 (five months only) to 154,817 in 1908, and has steadily increased to 913,723 in 1912.

*From the "Canal Record" of Apr. 16, 1912.

A Year's Experience with the Boston Public Works Department Organization

The new organization of the city engineering departments of Boston, Mass., was described in our issue of Dec. 22, 1910. The whole service was reorganized at that time under one engineering head, and for this office the city secured the services of Louis K. Rourke, then Commissioner of Streets and for four years previous, Assistant and Acting Division Engineer on the Panama Canal.

After a year's trial, Mr. Rourke reports that the organization is a success.* From Mr. Rourke's recent report on this first year's work of the organization we take the following extracts, which give in greater detail than our original article, the organization and the work of its various branches. The accompanying chart shows the scheme of organization diagrammatically with the salaries of the various bureau heads.

General Organization

The primary reason for the creation of the Public Works Department was to secure greater efficiency in the work of the Engineering, Water and Street Departments. Each of these departments was under a separate head and frequently there was a clash of authority, overlapping and duplication of work.

The Public Works Department as now organized is divided into three divisions. At the head of each division is a competent Division Engineer. The functions of the three divisions are, briefly, as follows:

The Bridge and Ferry Division has the charge and care of all bridges used as highways, which are in whole, or in part, under the control of the city; the care and management of the ferries owned by the city, including boats, slips, drops and buildings.

The Highway Division has charge of the construction and maintenance of roadways and sidewalks; the collection and removal of ashes, garbage, refuse and street cleanings; the care of lamps and the lighting of streets, parks and alleys.

The Sewer and Water Division has charge of the construction of sewers, catch-basins and waterways; the care of the water supply owned by the city; the installation of meters, water services and the laying and relaying of water mains.

The accounting force of the department has been merged into one body under the charge of a chief clerk. An office has been opened where all complaints, such as defects in streets, the nonremoval of ashes and offal, watering and oiling of streets, etc., are received and from there forwarded to the proper person for attention.

Bridge and Ferry Division

The division is under the general charge of Division Engineer F. H. Fay and the staff is divided into five subdivisions, the head of each of these reporting directly to the Division Engineer. The subdivisions consist of three engineering divisions, namely, the designing staff, under the direction of the designing engineer, having to do with the design of bridges, foundations, etc.; the construction staff, under the engineer of construction, having the supervision of the construction and principal repair work of bridges, foundations and ferry landings; and a special engineering staff under the engineer of special work, which has charge of grade crossing abolishment work and engineering work of a general nature, both for this and other city departments. In addition there is the bridge maintenance force, under the supervisor of bridges, and the ferry maintenance force, under the general foreman of the Ferry Service.

The positions of Division Engineer, the heads of the three engineering subdivisions and supervisor of bridges are filled by civil engineers, all of whom had previously been connected with the former City Engineer's office.

The organization of the Bridge and Ferry Division has worked satisfactorily during the year and has already been productive of good results. In the Bridge Service there has been notable improvement in the methods of caring for the city bridges, owing to effective coöperation between the engineering and bridge maintenance staffs.

Under the system formerly existing the City Engineer was required to make inspections and report upon the safety of bridges as well as to supervise all repairs affecting the strength of these structures. The care and maintenance of the bridges rested with the Superintendent of Streets. The result of this arrangement was that, although the City Engineer repeatedly recommended repairs on bridges, he had no authority to put his recommendations in force. His recommendations were frequently ignored and bridges, particularly those over railroads, were allowed to suffer through neglect, until in some instances they became unsafe and extensive repairs and even rebuilding were made necessary.

Highway Division

The division is under the general charge of Division Engineer James H. Sullivan. The subdivisions of the bureau include a paving service, which looks after the maintenance of all street surfaces, the pavement of streets and the construction of new streets; a sanitary service which takes charge of the collection and disposal of ashes, garbage and refuse of all kinds; a street cleaning service; a street water and oiling service, and a street lighting service.

For convenience in handling the garbage and refuse collection and disposal problem the city is divided into nine sanitary districts, in four of which the work is done by contract, while in the other four the work is done by city day labor. The contract districts are the outlying sections of the city, East Boston, Brighton, West Roxbury and Dorchester, and the disposal in nearly every instance was by inland dumps. The cost of collection and removal in these districts per ton varied from $0.77 to $1.25, including ashes. The average for the four districts was $1.12 per ton, or $0.57 per capita per year.

In the five central city districts, where the collection and removal was done by city day labor, the methods of disposal were by inland dumps, dumping in the sea and by contracts with rendering companies. The average cost per ton varied from $1.82 to $2.76, including ashes. The average cost for the entire five districts was $2.04 per ton, or $1.32 per capita per year.

Sewer and Water Division

The division is under Division Engineer F. A. McInnes, who states that:

The work is seriously handicapped by the number of employees who are unable to perform a reasonable day's work by reason of age or physical inability, a majority of these men having grown old in faithful service to the city; an extension of the pension system to embrace the old and deserving employees of all grades would serve the ends of justice and would best promote efficiency.

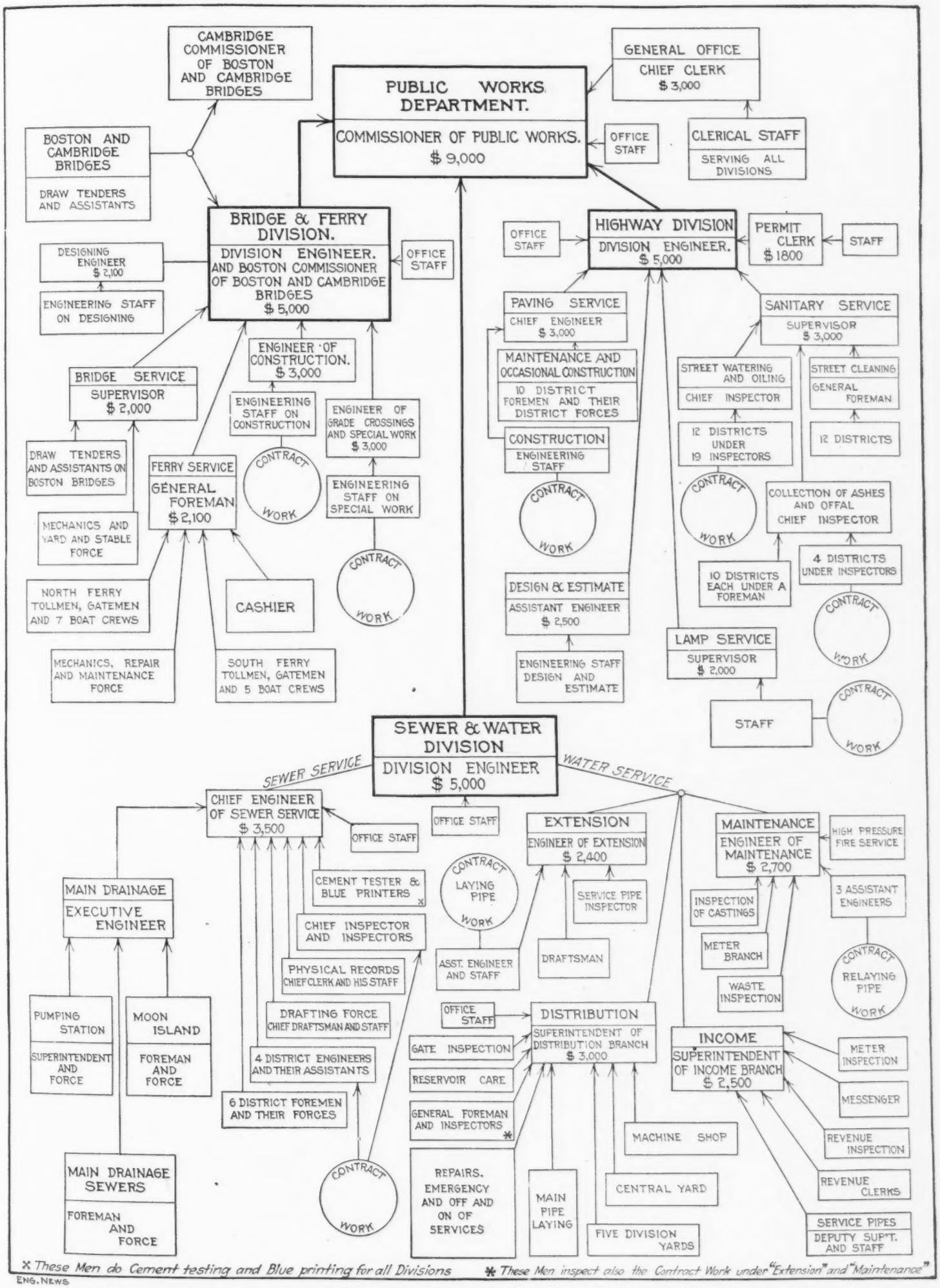
A part of the sewer work is also done by contract; this, however, amounted to only about one-eighth of the total construction work.

In the water service the work of laying and relaying pipe has been done almost entirely by contract, the award being made in each case to the lowest bidder. An innovation has been made in the manner of disposing of the old cast-iron pipes which are taken up in relaying and which, in the past, have been hauled by the city to the department yard, where they were broken up and sold for junk; the new system makes the disposal of the pipe a part of the contract by requiring the bidder to pay a stipulated price per ft. for it.

The work of waste prevention was carried on with a force of 13 men, substantial results being obtained in Dorchester, West Roxbury, Brighton, Charlestown and a part of Roxbury; in Charlestown the effect of the work was particularly noticeable, the consumption being reduced 1,500,000 gal. per day by two months' work of inspection.

The work of the Distribution Branch has been confined almost entirely to maintenance; that efficiency has increased is shown in the actual record of work done, the improvement being largely due to better discipline.

*Report of Public Works Department, Boston, Mass., 1911.



ORGANIZATION CHART OF THE PUBLIC WORKS DEPARTMENT, BOSTON, MASS.; L. K. ROURKE, COMMISSIONER

Some Construction Features of the Substructure of the Cumberland River Bridge, L. & N. Ry.

By Howard M. Jones*

The Louisville & Nashville R.R. Co. is now building a new low-grade, double-track railroad, known as the Lewisburgh & Northern R.R., south from Nashville, Tenn., to Athens, Ala. The maximum grade is to be 0.4% compensated for curvature. Ten miles south of Nashville is a chain of hills, the summit of which is about 500 ft. above the low-water level of Cumberland River. To secure the desired grade between the river and the Brentwood hills it was necessary to make the bridge 135 ft. above the low-water line, and to have a cut at Brentwood 70 ft. deep through solid rock.

The bridge is to be for a single track, but the main line south is to be a double track. The total length from abutment to abutment will be 2807 ft. The north approach consists of 1179 ft. of girder viaduct approach; the main river is crossed by seven truss spans, three deck spans of 124 ft. 6 in., one through truss span 300 ft., three through truss spans 200 ft, and the south approach is also a girder viaduct approach 352 ft. 6 in. in length.

Piers 3 to 8 are all funded on rock, which is from 16 to 20 ft. below the low-water line. Pier 2 is on concrete piles and Pier 1 on clay. The pedestal footings on the north side rest on a compact yellow clay, and a part of those on the south side are on rock and a part on clay. At the ends of the approach are pier abutments of rather unusual type, built of reinforced concrete, so as to permit the earth fill to take a natural slope around them. All of the substructure masonry is of concrete; a total of 17,500 cu.yd. being used on the substructure.

The Foster-Creighton-Gould Co., of Nashville, Tenn., was awarded the contract in the spring of 1912 to build the substructure and to erect the steel superstructure. The time fixed by the railway for the completion of the masonry was Oct. 1, 1913. Work was begun Apr. 1, 1912, and the masonry was completed by Jan. 1, 1913, or in one-half the contract time. It is so unusual that a work of this magnitude is completed so far ahead of time that it is thought a description of the layout of plant and methods used by the contractors by which such a result was made possible will be of interest.

Fig. 1 shows a general plan of the entire work, the location of the masonry, the plant used, and the quarry from which the rock was obtained. Reference is made below to this sketch in describing the work.

To obtain the rock footings for Piers 3 to 7 inclusive, it was necessary to excavate the sand and gravel which overlaid the rock in depths from 14 to 22 ft. As will be seen by reference to the sketch, Piers 4 to 8 were on a gravel bar. To add to the ordinary difficulties the City of Nashville had in years past used this gravel bar as a natural filter and had placed a large number of open rock masonry and brick galleries underneath it. Although not now in use by the City they gave a great deal of trouble in excavating as it was difficult to get the sheet piling through them or to fit close enough against them to exclude the water. The Gould steel sheet piling were driven to rock at all piers from 3 to 7, inclusive. This piling proved its excellence for there was no difficulty in

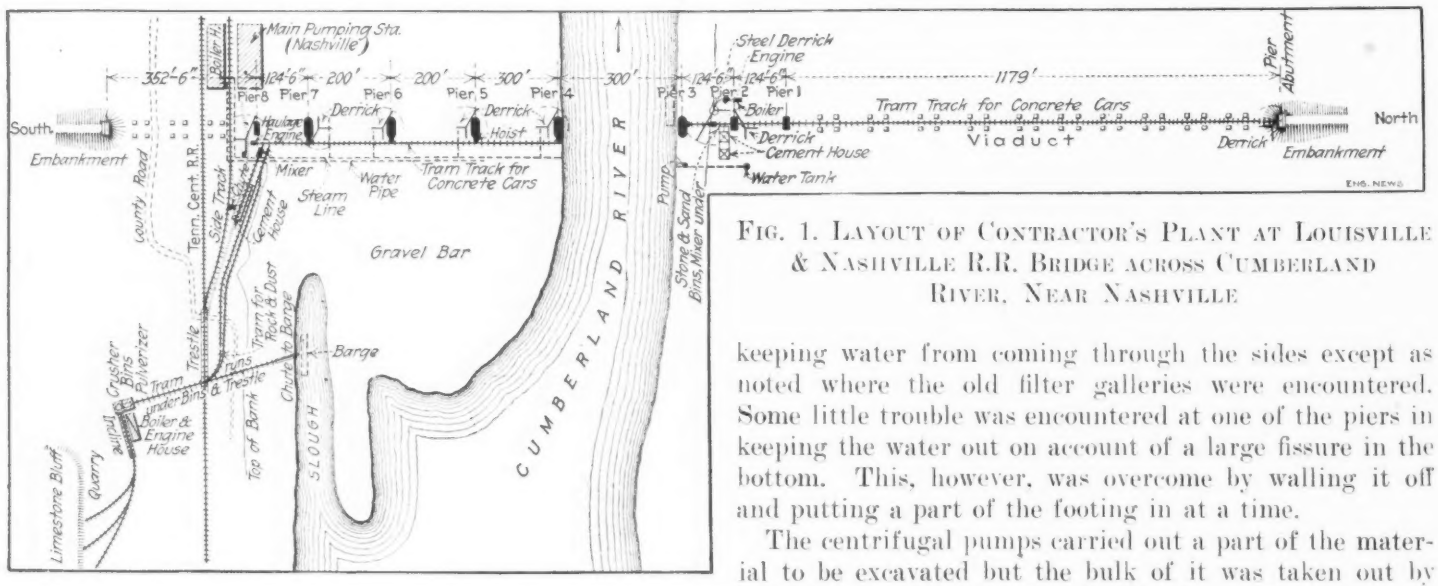


FIG. 1. LAYOUT OF CONTRACTOR'S PLANT AT LOUISVILLE & NASHVILLE R.R. BRIDGE ACROSS CUMBERLAND RIVER, NEAR NASHVILLE

keeping water from coming through the sides except as noted where the old filter galleries were encountered. Some little trouble was encountered at one of the piers in keeping the water out on account of a large fissure in the bottom. This, however, was overcome by walling it off and putting a part of the footing in at a time.

The centrifugal pumps carried out a part of the material to be excavated but the bulk of it was taken out by derricks rigged with clam-shell buckets. Derricks were set up at each pier site for the purpose and work on several piers was carried on at the same time. The last few feet of the material overlying the rock was usually so compact it could not be handled economically with the clam shells and laborers picked it and shoveled it into skips which the derricks handled, all excavated material being dumped by the derrick on the gravel bar just outside the coffer-dams. Pier 8 footing was obtained without the aid of a coffer-dam, open cribbing being all that was necessary. Pier 2 was founded on concrete piles, which were manufactured and driven by the contractors. Pier 1 was founded on clay.

Construction Methods

The organization for the work was as follows: A general superintendent in charge with two assistant superintendents, one superintendent in immediate charge of Division 1, which extended from the north abutment to and including Pier 3, the other superintendent in charge of Division 2, which comprised all work from Pier 4 to the south abutment. The superintendent of Division 2 also had charge of the crusher plant. Each division superintendent had under him gangs of carpenters, laborers for excavations, and concrete mixing and placing crews.

*Consulting Engineer, Nashville, Tenn.

Division 2—On Division 2, at the south side of the river, a derrick was set up on top of the bank near the railroad side-track and used as a general unloading derrick for form lumber, falsework poles, machinery, etc. This derrick also placed the concrete in Pier 8 and the four pedestal footings between the main track and side track. The cement house was so located on the side of the bank below the side track that the cement could be chuted down from the cars direct into the cement house. Cement was handled from the house to the mixer platform and tram cars. The mixer was located at a still lower elevation and fed from a receiving hopper. The platform over the mixer was covered in to enable the handling of cement in rainy weather without injury.

About 800 ft. to the east of the center line of the bridge a good quarry was located and a crusher plant was installed to make all the large and fine aggregate for the work, the limestone dust being used for sand. The crusher was elevated above the quarry so that after the product passed through the crusher it was handled by gravity through the screens into bins, from bins into tram-cars underneath the bins. These tram-cars were built to take one charge of crushed rock and limestone dust for a one-yard mixer, the car being divided into compartments so that the materials could be properly measured. As the ordinary run of crusher would not produce sufficient fine aggregate to furnish the sand content, a pulverizer was put in just beyond the end of the screen and the tailings from the screen were pulverized.

When a car had received its charge from the bins a mule was hitched to it and pulled it to the mixer. Four cars and two mules were found sufficient to keep the plant going to capacity. The cars were side-dump cars and emptied their load direct into a hopper which in turn fed the mixer, the cement being dumped into the hopper by a laborer located on the platform over the mixer. After the concrete was mixed it was emptied through a chute into a side-dump car which was carried out on the tram track to the pier wanted, then carried by elevator hopper to the height wanted. At Pier 6 an elevator was not used, but the concrete was handled by derricks, the upper part being built by a derrick located on the falsework which was put up for the steel erection. It will be seen by reference to the sketch that this tram track went from the mixer out to Pier 4.

The cars were handled both to and from the mixer by a haulage engine at the head of the tram track. This engine was geared so that it handled these cars with high speed. It was customary to work on two or more piers at the same time, placing the concrete alternately in them. While concreting was going on the carpenters were at work on other piers getting the forms ready for the next day's concreting. The piers were carried up in lifts of 6 ft., this being the safe height for one day's work.

The water for the mixing on this side was secured direct from the city supply. The pumping station of the City of Nashville happened to be located just west of the bridge site, and besides securing water from it, the steam supply for the mixer and the hoisting engines on this division during most of the time was secured from the power plant of the Station. The securing of this steam supply from the pumping station was a great convenience in that it avoided the trouble of having a great number of small boilers located where they would be difficult to handle if any sudden rise in the river occurred, and where coal loading was inconvenient. It also facilitated operations because there was never any time day or night when steam could not be had on a moment's notice.

Pier 8 and the four pedestals between the main and side track of the Tennessee Central R.R. were put in by the derrick shown in Fig. 1, the derrick taking the concrete direct from the mixer and placing it. The other pedestals on the south approach and the south abutment pier were put in by a smaller mixer ¼-cu.yd. capacity). This mixer was located at the south abutment pier and the concrete for the pedestals was elevated and carried by chutes to the points wanted. The materials for the concrete were hauled by wagon. At the south abutment pier the small mixer was located so that it discharged through chutes direct to foundations, and the pier brought up as far as possible in this manner. The upper part was put in by the use of an elevator.

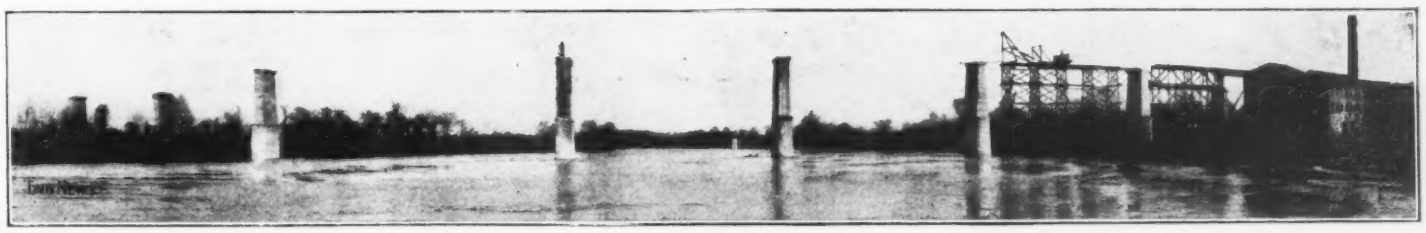


Fig. 2. Panorama of Cumberland River Bridge Piers

This small mixer was afterwards moved out on the gravel bar at the site of Pier 4 and was there used to assist in pushing the work on that pier. While operating at Pier 4 the materials for the concrete were taken direct from barges by a derrick. In this way it assisted very materially in making rapid progress possible.

Division No. 1—There was a natural slough on the south side of the river just about opposite the crusher plant. A tram track was run from the crusher plant down to this slough. The last 90 ft. of this tram was on trestle work. A barge would be brought up the slough to the end of the tram track and cars loaded with crushed rock would then be brought from the crusher plant and dumped through the trestle on chutes which emptied into the barges. After getting its load a tow boat would transfer the barge over to the north side of the river adjacent to the large derrick which was placed on the river bank for the purpose of handling all materials from the barges. This derrick was a steel derrick with a 108-ft. boom and bull wheel. It was founded on piles, for the bank at the point was not sufficiently stable to rest on.

It was found necessary to secure sand from the river for the work on the north side as the crusher and pul-

verizing plant could not produce limestone dust fast enough to keep the work on both sides going at the rate desired. Some gravel was also used on the north side work for the coarse aggregate. The pulverizer failed to produce the results guaranteed by the makers and for that reason alone was it necessary to get river sand.

A stationary mixing plant was located between Piers 2 and 3. Bins to contain rock and sand were located side by side over the mixer, and a double cement house with an open platform between was built just eastwardly from these bins. All were elevated so that the material was handled by gravity into the mixer. The large derrick took the material from the barges and placed it in the bins. It handled the cement in skips, taking up about 40 bags at a time and placing it on the open platform between the two cement houses. Laborers then handled the cement on trucks and stacked it in the houses.

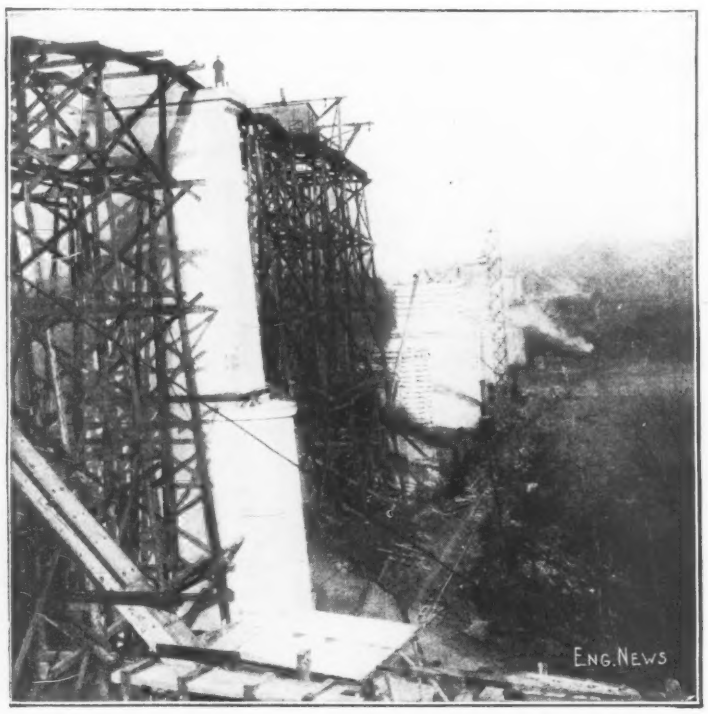


FIG. 3. VIEW FROM SOUTH ABUTMENT OF BRIDGE

The rock and sand were dropped into a measuring hopper and the cement emptied by hand into the hopper, the whole charge then being dumped into the one-yard mixer below. Leading from the mixer was the concrete tram track which was located on the center line of the bridge in order to facilitate the handling of the concrete to the pedestals on each side. This track was placed at sufficient elevation so that the concrete could be handled in chutes from the car to the place wanted. This tram track was also controlled by a haulage engine located at the end of the track. A derrick was placed at the north abutment pier to handle the reinforcing steel in this abutment pier and to also place the concrete. The abutment pier was first built and then the pedestals were built from north to south and the tram track shortened as the work progressed. Pier 1 was built by the aid of an elevator, as were also Piers 2 and 3. The derricks at Pier 2 was erected for the purpose of handling the leads for the pile driver used in driving the concrete piles in the foundation of Pier 2. A steam hammer was used. Pier 3 was brought up by the large derrick to about the height of top of bank, the derrick taking the concrete direct from the mixer in a bucket and dumping it in the pier. After it reached this height it was allowed to remain until the other work north of Pier 3 had been completed. The tram track was then extended out to Pier 3 and an elevator built there. The tram cars then handled the concrete to the elevator which in turn hoisted it to place wanted.

The Panorama view of the river piers (Fig. 2) was taken when the stage of river was such that the gravel bar was completely submerged. Fig. 3 is from a photograph taken looking northwardly from the south side and shows the gravel bar, location of tram tracks, elevators, hoists and some of the derricks.

There was no serious accident to men or equipment during the actual progress of the work. While the progress made was rapid, yet with the arrangements and organization of the work it could have been done much quicker if it had not been for the difficulty in getting the rock footing for two of the piers, which difficulties were fissures in the bottom, and the old galleries heretofore noted.

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Four-Cylinder Compound Locomotives of the 2:8:0 and 2:10:0 classes are being used by the Northern Ry., of France, for handling its heavy coal traffic. The former haul loaded trains of 950 to 970 tons on grades up to 0.8%, 750 tons on grades of 1.3%, and 1660 tons on practically level line. The latter can take trains of 950 tons on grades of 1.3% at a speed of 12 m.p.h. Their runs are about 155 miles in length. In order to get inside low-pressure cylinders of proper capacity (with the diameter limited by the space between the frames) the 2:8:0 engines have these cylinders made longer than the high-pressure cylinders. This is not sufficient, however, in the larger engines, and consequently the frame plates are cut away and replaced by steel castings which are offset so as to clear the inside cylinders, while at the same time they serve to carry the outside cylinders, which are made with flanges to bolt to the castings.

Piston valves are used for the outside (high-pressure) cylinders and balanced flat slide valves for the low-pressure cylinders, all valves being above the cylinders. The throttle valves are of the duplex type, each consisting of a cup-shaped or "wine-glass" shaped valve, with a smaller valve on the inside controlling ports through the cup. The first movement of the throttle lever (lifting the valve by the stem of the cup) raises the inner valve, and allows a small amount of steam to pass through these ports. The full throw of the lever lifts the main valve from its seat, and admits a full flow of steam beneath the cup. The two-wheel truck has a frame like the trail of a cannon, the extreme end of the trail or radius bar having a spherical bearing in a transom which is seated on the ends of the elliptic springs of the first driving axle. The point of support of the engine is a spherical bearing at about the mid-length of the radius bar and this has a lateral movement controlled by horizontal springs on each side. The dimensions of the engines are given below:

Type of Engine	2 : 8 : 0	2 : 10 : 0
Driving wheels (8)	5.08 ft.	(10) 5.08 ft.
Truck wheels (2)	3.40 ft.	3.40 ft.
Tender wheels (6)	4.10 ft.	4.10 ft.
Wheelbase, driving	19.55 ft.	25.00 ft.
Wheelbase, engine	27.75 ft.	33.20 ft.
Wheelbase, tender	10.16 ft.	10.16 ft.
Wheelbase, engine and tender	48.77 ft.	53.8 ft.
Weight on drivers	72 tons	88.3 tons
Weight of engine	82 tons	99.0 tons
Weight of engine empty	75 tons	90.0 tons
Weight of tender, loaded	38½ tons	38.5 tons
Weight of tender, empty	17 tons	17.0 tons
Boiler, diameter	6 ft. 0 in.	6 ft. 0 in.
Boiler, rail to center	8 ft. 6 in.	9 ft. 1 in.
Tubes (Serve type) (90)	2.8 in.	(90) 2.8 in.
Tubes, superheater; No. & diam. (24)	5.3 in.	(24) 5.3 in.
Tubes, length	14.76 ft.	19.68 ft.
Firebox (Belpaire)	10.6x3.26 ft.	10.6x3.26 ft.
Heating surface; tubes & superheat tubes, sq.ft.	2093	2506
Heating surface; firebox	186	186
Heating surface; total	2279	2692
Superheating surface	481	677
Grate area	34	34
Cylinders; hp., outside (2)	16.8x25.6 in.	19.6x25.6 in.
Cylinders; l.p., inside (2)	22.8x28 in.	27.2x28.0 in.
Rail to top of smokestack	13.8 ft.	13.8 ft.
Length over engine and tender	57.26 ft.	62.28 ft.
Water in tender	4500 gal.	4500 gal.
Coal in tender	8800 lb.	8800 lb.

A Street-Railway Valuation

SYNOPSIS—Bion J. Arnold's recent valuation of the street-railway lines of Kansas City, Mo., is of timely interest on account of the recent legislation for the valuation of all the railways of the United States. Mr. Arnold tested the fairness of the valuation made by comparing it with the value computed under four different methods.

In July, 1912, Bion J. Arnold, of Chicago, was appointed a special commissioner by the U. S. District Court for the Western District of Missouri to investigate and report to the court what in his opinion was a fair and reasonable sum to represent the capital value of the properties embraced in the Metropolitan Street Railway System of Kansas City for adoption in a contract for new franchises in the municipalities wherein the properties were operated, together with the various elements of such value and its apportionment between municipalities. This appointment followed a petition of the receivers of the Kansas City Railway & Light Co. for a disinterested valuation and data which would serve to determine all the work needed to establish this system in good physical condition and allow the company to give service commensurate with the city needs, taking into account the present and future necessary operating conditions.

Mr. Arnold's report is dated Feb. 3, 1913, and is contained in three volumes, the first giving the discussions of valuation principles, a history of the lines, franchises and ordinances, and a section on transportation requirements. This volume contains the matter of greatest engineering interest. The second and third volumes give details of the records of construction, equipment, expenditures, etc. None of the reports have been widely distributed.

Mr. Arnold first points out that the determination of value, under the court orders, for refunding and the question of rehabilitation, brought up by the receivers, are closely related. The proposition for refunding and securing additional money is actually covered by one future financing. He then proceeds to answer the specific questions of the court and follows this with a recommendation asked for by the receivers, noting that he was asked to determine other elements of value than the engineer is ordinarily asked to find and which are usually added to the engineer's value by the court or those to whom the report is made.

The discussion of principles behind Mr. Arnold's valuation and his application to the specific case in hand are given below *in extenso*. Necessarily no reprint of the detailed data which were built up is possible in these columns. The date of the valuation is of May 31, 1912, the end of the fiscal year of the Street Railway System.

THE PROPERTIES AND THEIR LOCATION

The Metropolitan System consists of the street-railway properties of the Metropolitan Street Ry., herein called the Metropolitan Company, including that which was formerly owned by and conveyed to it by the Central Electric Ry. Co., herein called the Central Company, and that of the Kansas City Elevated Ry. Co., herein called the Elevated Company, all operated under franchises from the different municipalities through which they operate. Intimately connected therewith, though strictly not part of the System and not in the hands of the receivers, is the property of the Kansas City and Westport Belt Ry. Co., herein called the Westport Company, the stock of which is, as is that of the Metropolitan Company, owned by the Kansas City Ry. & Light Co., and being operated in connection with the Metropolitan, is probably popularly regarded as part of the System. It operates an electric railway, heretofore outside of, but now mostly within, the recently extended limits of Kansas City, Mo.

The Metropolitan System, exclusive of the Westport Company, contains 259.81 miles of single track, of which 182.28 miles are in Kansas City, Mo., 5.26 miles in Independence, Mo., 9.73 in Jackson County, Mo., outside of cities therein, 58.17 miles in Kansas City, Kan., 4.37 miles in Rosedale, Kan. This System is a completed whole, having with the work in the report hereto attached mentioned, the requisite equipment and power for the operation of a practically perfect street-railway system. The Westport Company has 16.87 miles of track in the present limits of Kansas City, Mo., and 4.23 in Jackson County, outside of the city limits. Divorced from and operated wholly apart from the Metropolitan System, it has a very considerable future prospective value in addition to the present actual value of its physical property, a large portion of which is real estate and which has greatly increased in value by the growth of the city.

VALUES FOUND AND VARIOUS ELEMENTS THEREOF

In estimating the values of these properties, the same have been determined with reference to that which is just and reasonable in view of the special purpose for which the valuation is made, i.e., "for adoption in a contract for new franchises in the municipalities wherein the properties are located." The uses to which the properties are put have been carefully considered as well as those of which they are really capable and to which they will probably be put, the original cost of construction, the cost of actually duplicating same new today, the present condition, the advantages and economy in operating the property as a whole, the earning power (at minimum reasonable rates), the territory reached, the past and reasonable prospective growth of the communities in which the property is located, the transportation facilities established between these communities, the density of the territory served, and character of the improvements therein. There has also been taken into consideration the amount of bonded debt, its relation to the value of the present physical property, the market value of the bonds, the necessity for new money to make present improvements and future extensions, and the contractual relations that must exist between the company and the public in order that such new money may be secured at a minimum cost.

The conclusion reached based upon the above elements, as fully analyzed in the schedules hereto attached [but not here reprinted—Ed.], is that the fair and reasonable sum to represent the capital value for adoption in any new contract with the municipalities wherein the properties are located is as follows:

Metropolitan System, exclusive of the Westport Company	$35,000,000
Westport Company	1,700,000
Total for the two properties	$36,700,000

APPORTIONMENT OF VALUE

These values thus found should, in the judgment of your Commissioner, be apportioned as follows:

Metropolitan System	
In Kansas City, Mo.	$28,000,000
Independence, Mo.	350,000
Jackson County, Mo.	700,000
Kansas City, Kan.	5,600,000
Rosedale, Kan.	350,000
Total	$35,000,000
Westport Company	
Kansas City, Mo.	$1,200,000
Jackson County, Mo.	500,000
Total	$1,700,000

There are many methods of making such apportionment, among which may be mentioned the following: On the track mile basis; on the basis of the car miles operated; on the basis of the appraised value of the physical property; on the actual money invested; and on the gross revenue originating in each division, which latter method is at this time used in apportioning the revenue paid to the cities under the 8% clause of the Peace Ordinance.*

*An ordinance of 1903, running to 1925, adopted as a basis of settlement of disputes then existing between city and company. Under it, large sums have to be paid for construction of bridges, etc., such as often are built by a city; 8% of the gross receipts is paid to the city, partly in lieu of taxes; certain light and power service has to be furnished the city; eight miles of track has to be constructed per year, which has resulted in an overbuilt system.—Ed.

An analysis shows that 81% of the appraised value, 83% of the investment value, 83.8% of the gross revenue, 79% of the car miles and 75.9% of the track miles are located or originate in Missouri. The true division of the recommended fair value cannot be determined by averaging the above percentages, but since the principal elements to be considered in such a division, namely, the actual investment and the gross revenue, are in substantial agreement, your commissioner believes that taking all the facts into consideration and so long as the property is operated as an entity, the division between Missouri and Kansas on a basis of 83% and 17%, respectively, is fair and reasonable.

The study of the various considerations affecting this apportionment has been further carried out so as to divide the value apportioned to Missouri between Kansas City, Independence City and Jackson County, and to divide the value apportioned to Kansas between Kansas City and Rosedale. As a result of this determination the complete apportionment is as follows:

Kansas City, Mo.	80%
City of Independence	1%
Jackson County	2%
Total Missouri	83%
Kansas City, Kan.	16%
Rosedale	1%
Total Kansas	17%

Since the value returned for the Westport Company is practically that shown in the appraisal of that property, the apportionment of such value between Kansas City and Jackson County, Mo., is that shown by said appraisal.

The foregoing valuations contemplate (1), that the value fixed, and the new capital hereafter advanced, shall as an investment, be protected so as to secure the principal, so long as invested, with a reasonable return thereon, and (2), that the owners shall recognize and yield to the public the right, if it so desires, to amortize or retire, in some just way from future net earnings, the entire value or at least so much of the total actual value of the property herein given or as finally fixed as that value exceeds the value of the physical property then producing the service, thus giving the city the right either ultimately to buy the property at such decreased value or take the benefit in reduced fares or otherwise, if the income would then justify it. At that figure the security would be so ample that money could, for a street railway in a community like that about Kansas City, be borrowed thereon at the lowest rate of interest and the property acquired or the benefit of the excess taken in some other form by the public.

BASIS OF VALUATION ADOPTED

In thus determining the said values consideration has been given to the purposes for which the valuation is made, the uses to which the properties are put and to which they are reasonably adapted.

In ascertaining the fair value for the uses to which the properties are and can be reasonably put, there should be taken into consideration these elements of value, each one of which is important, but no one of which is controlling: The extent, character and present condition of the property, together with its actual cost in the past; the cost to reproduce it just as it now exists; the depreciation of the property because of its use and actual condition; its earning power, past and prospective; the amount of earnings and operating expenses; the value fixed by tax-assessing boards; the fact that it is a going concern operated as a whole, connecting various municipalities in different states and communities; the location and connections of its different lines with the probable permanency thereof, as compared with being upon other streets with other connections; the size and reasonably certain future growth of the communities, and the parts thereof served by the cars; the density of population and traffic, together with the nature and probable permanency thereof; the character and facilities of the property for rendering the kind of service to which the public is entitled both now and in the future, with the largest saving in the investment of new capital; and the amount and value of its stocks and bonded indebtedness, together with the financial history of the company. In this way, and by considering all such elements, the fair and reasonable value of the property can be ascertained.

Many methods have been adopted by courts, experts and students of the problem in valuing street-railway properties. Among these are, the ascertainment of, (1), the actual cash investment therein and the return actually had in the past thereon; (2), taking, as was done in Chicago and Cleveland, the actual cost of reproduction less depreciation and adding thereto a fair and reasonable allowance for future earnings, which latter sum is intended to cover the intangible value or various other elements which go to make up the real value; (3), the value based upon the deferred earnings upon the actual investment; and (4), the fair market value of the property. These methods will be considered in their order. Tested, in the light of any one of them it is manifest to your commissioner that the amounts hereinbefore fixed for the purposes aforesaid are reasonable.

(1) THE ACTUAL CASH INVESTMENT IN THE PROPERTY AND THE ACTUAL RETURN HAD THEREON

The actual cash investment in the properties of the Metropolitan System, exclusive of those of the Westport Company, is $34,298,061.45. This is wholly regardless of the bonds, liabilities or stocks outstanding. From this investment there have, since the existence of the property, been received over and above operating expenses, sums equaling only 5.36% annual interest thereon, out of which has been paid all interest charges and all moneys distributed to owners or stockholders as dividends or otherwise. One of the first things to which one naturally turns in a fair consideration of a situation of this kind, is the actual investment and return had thereon regardless of the amount of stock, bonds or debts outstanding. A company must, with actual cash investments, meet the changing demands of the public for improved methods of service with actual cash investments in much new property to take the place of property not yet worn out. When cable lines superseded horse cars, and electricity took the place of the cable, the company necessarily had to meet the changed situation. When extraordinary floods washed away bridges, new ones had to be substituted.

If after meeting such changes and others of like nature, the owners have drawn in returns considerably more than the ordinary rate of interest, there has, to the extent of that excess, been repayment largely, if not wholly, for the entire investment, including the losses thus sustained. If, however, the returns have not exceeded a reasonable interest rate, fairness demands that there be protection for the investment which was really made, provided the records show that the property has been efficiently managed.* A company which has, in excess of interest charges, paid annual dividends of 10, 20, or 30% is in a very different situation from one which has in good faith invested its money and received returns of less than 6%, out of which it has been compelled to pay interest upon its bonded indebtedness. In the case of the Metropolitan System there are records unusually complete as compared with roads as old throughout the country, covering all expenditures made throughout its entire life. While some books for certain periods are absent, and seem not to be in existence, yet books, vouchers and records (the vouchers for all the time) appear from which there can be determined satisfactorily and with reasonable certainty the actual cash investments in the property and the actual cash returns therefrom.

In arriving at the actual cash investment in the Metropolitan System from the above records there has been deducted from the total expenditure of $35,991,461.15, the sum of $1,693,400, now carried in its capital account, which amount represents the stock used in purchasing acquired properties and presumably for which no cash was invested, leaving the net cash cost of the Metropolitan System $34,298,061.15, upon which there has been a return of only 5.36% annual interest. The public has benefited by the changes necessitated on account of the supersession and abandonment of inadequate or obsolete property and the company should have the opportunity, in view of the exceptionally low rate of return it has received to date, of earning these losses back out of the property, especially if the owners concede the right to the public to retire or amortize a large portion of this value from future earnings.

None of the books, papers or documents of any of the former owners or operators appear to have been in the possession of the Westport Company, and it is not known that they exist. They would refer to transactions so far in the past that it is wholly unlikely they have ever been preserved. The cost of the property of the Westport Company and the returns thereon in the past seem therefore absolutely impossible of ascertainment.

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*This is especially applicable where a company has spent large sums in the construction of municipal improvements and in extensions into new and comparatively unprofitable territory, which has later built up to the advantage of the city, and which ultimately would be to the advantage of the railway company, if it is allowed to continue to operate. That both these conditions exist in the Kansas City situation is evidenced by the large amount of money spent by the company for bridges and viaducts and by the excessive track mileage now in operation as compared with other cities.

(2) THE PRESENT COST OF REPRODUCTION LESS DEPRECIATION AND ADDING A FAIR AND REASONABLE SUM FOR THE INTANGIBLE ELEMENTS OF VALUE

In order to ascertain the cost of reconstruction, complete inventories have been taken and are returned herewith, unit prices representing the value at which the various items of property could be replaced today in like kind have been applied. In this way there has been found just what it would cost to reconstruct new the physical property as it exists today. It is manifest, however, that the property is not new, but is somewhat depreciated. The present value then of the physical property after it has been used, regardless of intangible or other value, is not the "cost to reproduce new," but that cost less depreciation.

The method of ascertaining this cost new is more fully stated in Schedule III hereto attached. [Not here reprinted. —Ed.]. This "cost new" value excludes promoters' profits or development expense and simply represents the investment that would be required to reproduce new today the physical property as it stands, no attention whatever being paid to any expenditures that may have been made, in the past years on account of horse-car lines, cable lines, or any portions of the electric lines which may have been constructed and later worn out in service or abandoned.

The present or depreciated value of the existing physical property has been arrived at by determining the depreciation which has occurred in the existing property between the time of its installation and the date of the appraisal. Certain items of the property, such as real estate, working capital and supplies, are not considered as depreciating in value, because their value for reproduction purposes is just what it is today. Other items of the property, such as power plant equipment, rolling stock, and buildings, are known to depreciate from the time when they are put into service. Estimates have been made as to the length of time which the various items of the property should be able to render efficient service, and depreciation rates have been determined based on such length of service, and these rates have been applied to the various items of the property to determine the remaining service value in the property or the total present value of the physical property. Such a present value measures the intrinsic value to the operating company today of the physical property, which it is using in the conduct of its business, regardless of the intangible elements of value hereinafter mentioned. The values of the property of the Metropolitan Company exclusive of that of the Westport Company, as determined on this basis, are:

Cost to reproduce new the physical property	$27,327,549.00
Less depreciation	5,792,514.77
Present value of the physical property alone	$21,535,034.23

The above value of the physical property is based upon the assumption that the investment is protected by fair ordinance stipulations and that as a result the cost of legal and general expense, as well as the cost of financing, would be kept at a minimum. Should the investment be unprotected as is the case at present, the combined cost of the above expense would be increased a total of about 5%, and on such basis the cost to reproduce the physical property would be as follows:

Cost to reproduce new	$28,643,733.02
Less depreciation	5,958,015.19
Present value of physical property	$22,685,717.83

These values, however, so far as the Metropolitan System is concerned do not represent the full value of the property, since they take no cognizance of the fact that the value of the physical property could not, at a place like Kansas City, represent the full value of the street railway as a large system. It is a going connected concern, already built, with the right to operate for a number of years in the future, and in many instances without limit of time. No matter how much, if anything, stockholders or bondholders may lose, or where the ultimate ownership may go, the property is there and will be operated by some one without again meeting the difficulty and expense of raising new money to duplicate it.

Moreover it is manifest that track and cars located and operated in a thickly populated community with the right to continue such operation are of greater value than similar tracks and cars located and operated in a sparsely settled community.

In Chicago and Cleveland this intangible value was ascertained by finding the probable future earnings during the period in which the companies had a right to operate under their unexpired franchises.

In lieu thereof, taking everything into consideration, it would be a fair thing to assume that the rights of the Metropolitan System, as they now exist, exclusive of those of the Westport Company, will in some form, in any event, continue until June 1, 1925, and the value of its earning capacity during that time dependent upon that right alone exclusive of anything on that account from the Westport Company, or other franchises extending beyond that date should be ascertained. When this is done if a fair, reasonable and just result follows such result may be said to stand for in lieu of and cover the intangible value, or the other various elements which enter into real value. This method of ascertaining the intangible value excludes any estimate of the value after 1925 of first, the permanent grants to the Metropolitan unlimited as to time from Independence, Mo., and from Jackson County, the latter including the parts of lines in the county taken into Kansas City by extension of its limits since 1902; second, the grants from Independence, Mo., one unlimited and others running to 1936 and 1941, respectively, and of Rosedale, Kansas, extending to 1929. Moreover, in this way, all future rights of any kind of the Westport Company are excluded, although it apparently has the permanent unlimited right to forever run over its own private right-of-way without any further municipal grant. The method of so calculating the value is substantially as follows:

Ascertain the net profits to be derived by the company each year till June 1, 1925, deducting from the gross earnings from operation, first, operating expenses, including proper allowances for maintenance, depreciation and taxes; second, fixed or interest charges upon the depreciated tangible value of the property as hereinbefore found, which is used to produce the gross receipts. After the net returns are thus estimated, ascertain the present value thereof by discounting same at the rate of 5% per annum. From the present value thus ascertained deduct the present value of future interest charges which must be met, to support the constantly increasing capital necessary to produce the future earnings. When this deduction is made, the balance left is the present value of the net profit if the company operates the Metropolitan system until June 1, 1925. Tested in this way the result on the basis of a protected investment is:

Present value of future net receipts	$25,832,411.32
Present value of future interest charge	12,340,870.05
Net intangible value to company	$13,491,541.27

On the basis of an unprotected investment the above intangible value would be as follows:

Present value of future net receipts	$25,832,411.32
Present value of future interest charge	12,881,126.50
Net intangible value to company	$12,951,284.82

This net or earning value then is the sum representing intangible or other elements of value to be added to the cost of reproduction less depreciation. The value of the property as determined by these methods is as follows:

On the basis of a protected investment:

Cost to reproduce new	$27,327,549.00
Less depreciation	5,792,514.77
Present value of physical property	$21,535,034.23
Net intangible value to company	13,491,541.27
Present value to company	$35,026,575.50

On the basis of an unprotected investment.

Cost to reproduce new	$28,643,733.02
Less depreciation	5,958,015.19
Present value of physical property	$22,685,717.83
Net intangible value	12,951,284.82
Total present value	$35,637,002.65

Either of these valuations substantially agree with the actual investment as determined by the preceding method and also as determined on the deferred earning basis with a 6% return hereinafter discussed.

(3) ASCERTAINING THE VALUE FROM THE BASIS OF DEFERRED EARNINGS UPON THE ACTUAL INVESTMENT

Another method, approved by some experts and adopted in some instances in Wisconsin, and by the French and Swiss Governments in the acquisition of steam railways for national ownership, is as follows: Ascertain each year the actual investment in the property, deducting the value of superseded property in the year it was superseded, and estimate a fair return on this net investment. Deduct from such return the net income after paying operating expenses, including maintenance, renewals and taxes, charging to operation, however, the cost of superseded property in the year when superseded. Then compound each year the de-

ficit or surplus, as the case may be, between the fair return and the said income. The result will show a sum representing the accrued loss estimated upon the basis of a return at a given reasonable rate or per cent. The total of the accrued loss, together with the actual investment in existing property, will then represent the fair value of the entire property.

Or under a modification of this method a fair return may be figured upon the total investment without charging to operating expenses the cost of superseded property, this method retaining in capital account, the investment in property which has been superseded. There have been prepared tables showing the value thus ascertained upon the basis of an assumed fair return of 6% and 7% respectively. The values thus ascertained are:

	6%	7%
1. Distributing superseded property in the year when abandoned	$36,044,214.14	$43,788,507.87
2. Retaining superseded cost in capitalization	36,040,312.69	44,201,927.05

This method allows the investor, wholly regardless of bond and stock issues, and liabilities outstanding, the actual amount invested, with a fair interest return thereon, charging him, however, with every dollar earned from the property. Tested by this method, and considering the purpose for which it is made, the value returned by your Commissioner is found to be conservative.

(4) THE FAIR MARKET VALUE

It has been said that a reasonable fair market value is that sum at which a fair buyer would buy and a fair owner would sell, both being willing to deal at a fair price. So testing and considering the question in the light of one's experience in and judgment of like properties in the large communities of the country, and taking into consideration the above mentioned elements as well as the entire situation and surrounding conditions, the fair and reasonable market value of the properties is in the judgment of your commissioner not less than the sums hereinabove given.

THE WESTPORT COMPANY

The actual reproduction cost of the property of the Westport Company less depreciation is $1,685,052.06, or practically the amount found as the value, $1,700,000. There is no way in which to calculate its value upon the basis of the actual investment and former returns therefrom, nor upon the basis of deferred earnings upon the actual investment. The appraised present value of $1,700,000 is nearly a million dollars in excess of the actual cost to the Westport Company. The depreciation, proportionate to the cost of reproduction, is much less than with the Metropolitan System. These things are accounted for by the large amount of real estate owned by the company which has greatly increased in value on account of rapid growth and development of the city south of Brush Creek. This growth is bound to continue in the future with further increase in the value of land. The estimate of $1,700,000 is conservative whether or not the property goes into the Metropolitan System. If it does go in, no consideration is taken of the value of its future rights, nor of the fact that it needs no franchise, but any extra value upon such account is treated as covered by the general value of the Metropolitan System. So upon the whole, its present value under all the conditions and for the purposes of representing part of the capital sum in a contract is fixed at substantially the cost of reproduction less depreciation. The detailed value of the physical property of this company has been determined in the same manner as that of the Metropolitan Company and is as follows:

Cost of reproduction	$1,807,331.66
Less depreciation	122,279.60
Present value of physical property alone	$1,685,052.06

SUMMARY OF VALUES AND RECOMMENDATIONS

The values of the property for the Metropolitan System, exclusive of the Westport Belt Ry., as determined by the methods discussed above, are in substantial accord, and have all been taken into consideration in arriving at the value returned for the Metropolitan System. These values are summarized as follows:

(1) Actual cash investment in the property:

Investment in the present property	$25,214,870.67
Investment in superseded property	9,083,190.48
Total investment	$34,298,061.15

(2) (a) Value as determined from the present value of the physical property alone and the intangible value on the basis of a protected investment:

Cost to reproduce physical property new	$27,327,549.00
Less depreciation	5,792,514.77
Present value of physical property alone	$21,535,034.23
Intangible values	13,491,541.27
Total value	$35,026,575.50

(2) (b) Value as determined from the present value of the physical property and the intangible values on the basis of an unprotected investment:

Cost to reproduce new	$28,643,733.02
Less depreciation	5,958,015.19
Present value of physical property	$22,685,717.83
Net intangible value	12,951,284.82
Total present value	$35,637,002.65

(3) Investment in property determined on premise that company is entitled to fair return on capital actually invested:

(a) Capital value obtained by adding to total investment the accrued deficit in operation below a fixed term, superseded property being retained in capitalization, using 6% and 7% as assumed fair rate of return:

	6%	7%
Total investment	$34,298,061.15	$34,298,061.15
Accrued loss	2,742,251.54	9,903,865.90
Total capital value	$36,040,312.69	$44,201,927.05

(b) Capital value obtained by adding to net investment the accrued deficit in operation below a fixed return—the superseded property being charged to operation in the year in which it was removed, assuming 6% and 7% rates of return:

	6%	7%
Total investment	$25,214,870.67	$25,214,870.67
Accrued loss	10,829,343.47	18,573,637.20
Total capital value	$36,044,214.14	$43,788,507.87

In determining the recommended value hereinbefore returned, the following consideration has been given to the above values:

By the first method the actual cash invested is shown to be $34,298,061.15. This amount taken from the records of the company, and adjusted to exclude all charges not represented by cash expenditures, does not, however, include certain expenditures for property that have been paid from time to time out of receipts and charged to operation, and which since the date of the receivership have been exceptionally large, as since that date over 21% of the gross receipts has been spent upon maintenance, renewals and betterments. For this reason the above amount is somewhat below the actual cash put into the property.

The second value, as determined by the appraisal of the physical and intangible value, on the basis of a protected investment, is $35,026,575.50, and on the basis of an unprotected investment is $35,637,002.65. Values by this method have been used in Cleveland and Chicago, and are generally conceded to be fair both to the company and to the public.

The value, as determined by the third method, based on the premise that the company is entitled to a fair return on the capital actually invested, is over $36,000,000, if 6% be used as the fair return, and is approximately $44,000,000, if 7% is used as a fair return. Since the amount of superseded property has been high, the values as determined by this method must necessarily be correspondingly high, and for this reason more weight is given to the value arrived at by the use of the 6% rate, although ordinarily, in the case of an unprotected investment, the 6% rate would be considered low, and a 7% interest rate would probably be used.

Taking into consideration all of these values, and all of the conditions as found, and as stated in the accompanying schedules, your Commissioner has returned the lump sum value of $35,000,000 for the Metropolitan System, and $1,700,000 for the Westport Belt Railway, proportioned as hereinbefore specified.

As these values are for the purpose of a municipal contract, the company should agree, if the public so desires, to retire or amortize out of earnings in some reasonable way, and during a reasonable time, such intangible value as may be finally determined upon, so that the public will eventually be called upon to pay a rate of fare which will be a fair return on the actual value of the physical property then producing the service after the intangible value has been amortized and retired.

PRINCIPLES GOVERNING FAIR ORDINANCE PROVISIONS*

An ordinance embodying efficient and economical contractual relations between a transportation company and a city should be based upon the following principles:

(A) The contract or ordinance should stipulate the agreed fair value of the property, which should be so determined as to protect the interests of those whose money is legitimately invested in the creation of the property, and in cases where the returns on the actual investment have not been excessive, as in the case of the Metropolitan System, should assure to the owners a fair return on such value.

*Part of Schedule I.—Ed.

(B) The ordinance should provide for supervision by the city or state of the capital expenditures to be made from time to time by the company, in order either to rehabilitate such portions of the property as may be found in need of rehabilitation, or to make such extensions as are necessary to give adequate service, such supervision of capital expenditures to be made for the purpose of assuring investors in the securities of the company that their investment is represented by money actually put into the property, thus tending to decrease the rate of return that will be demanded by investors, and at the same time for the purpose of securing the minimum capital investment, as well as the minimum rate of return, all of which serves to decrease the cost of transportation service in a given territory.

(C) The city or state should supervise not only the capital expenditures, but also the operation of the property to such an extent as may be necessary in order that the service maintained by the company shall be adequate and of as high a character as is consistent with the returns from operation.

(D) The surplus from operation that remains after the payment of operating expenses, including taxes, maintenance, and a proper reserve for depreciation, and after the payment of fixed charges, consisting of the agreed minimum fair return on the capital invested, should be devoted to the following purposes:

(1) A part to an amortization fund for the purpose of ultimately retiring any part of the capital investment that is not represented by physical property.*

(2) A part to the company as profit for efficient operation, unless it should be decided to limit the company to a fixed return upon its investment, which return should be somewhat higher than the minimum return referred to in paragraph (D).

(3) A part to the city as its share in the net profits, if the city so elects in the ordinance, although, for the best interests of the citizens, it is questionable whether the city should retain any portion of the profits from the transportation business, the better policy being that any such surplus, which in some cases has been paid to the city, should be utilized in improving the service, extending the system, or in establishing a pension or other fund for the benefit of the employees of the company.

(4) The reduction of fares after such time as the company has been able to decapitalize all that portion of its capitalization agreed to by the ordinance which is not represented by physical property, or for the decapitalization of the value of the tangible property, should this be deemed advisable.

If such amortization feature is incorporated in the ordinance, the period of time over which the amortization of such part of the capital as is to be retired takes place should be great enough so that the rate per annum is such that the company can set it aside without jeopardizing its legitimate fair return as stipulated in the ordinance, or without crippling the service. As the decapitalization proceeds the fixed charge will decrease a proportionate amount, thus increasing the amount available for service in the form of more cars or for increased wages or for a pension fund for employees; for extensions of the property without corresponding increase in capitalization; or for the reduction of fares.

Views upon how far decapitalization should apply and continue vary, some contending that not only the intangible but also all of the tangible property should eventually be amortized, so that the property would in time become possessed by the city without expenditure of money therefor on its part. Others contend that, in addition to amortizing the intangible value, there should be amortized only that portion of the value of the physical property which represents depreciation, and that such value as then remains in the property should be carried as a continuing investment by the company, in the case of a privately owned company, or by the municipality, in the case of a municipally owned property, and this investment is usually with present properties (owing to their comparatively recent construction and rapid development into new territory) about 75 per cent. of their cost to reproduce new value; although in properties restricted to certain districts and not requiring extensions, reconstruction or betterments, but only requiring maintenance and renewals, this value would be about 60 per cent. of their cost to reproduce new value. Therefore, if it is the policy of the city to retain the right to ultimately acquire the property of the company, the terms for so doing should be agreed upon and stipulated in the ordinance, and the character and extent and method of amortization therein provided for.

The adoption of the value shown in the report in an ordinance such as outlined above will substantially protect the investment of the Metropolitan Company, as it will assure to it in the future such a minimum rate of return on money actually invested in the property as will be determined by the new ordinance. It will not, however, fully reimburse it for any failure to earn such a fair return on the capital invested during the past years. This amount will be fair to the city, in that it limits the amount to be paid to the operating company in the way of fixed charges and profit to only a fair return on the money actually invested, thus providing the public with service at a minimum fair cost.

The decapitalization of the intangible values herein referred to cannot generally be accomplished economically by gradually retiring outstanding securities that have been issued for a fixed time. It can be accomplished, however, by increasing the physical property without correspondingly increasing the capitalization. The agreed portion of the net revenue from operation appropriated to the amortization fund should be used in the purchase of such additional physical property. Thus, the value of the physical property actually furnishing the service will ultimately equal the capitalization. The rate at which such intangible value can be eliminated from the investment is determined entirely by the rate of increase of the gross revenue and by the disposition of the net revenue agreed upon in the ordinance.

*Such values are known as development expenses, and usually consist of preliminary technical expense, legal expenses during formation of the company not connected with construction expense, cost of consolidation and reorganizations, sometimes a reasonable promoter's profit, supersession of equipment due to the rapid advance of the art, reconstruction due to unforeseen contingencies, brokerage, discount or premiums on securities, and sometimes franchises and going values, including losses during early operation, all of which should eventually be amortized and eliminated from the value of the property, upon which the public should be finally expected to pay a rate of return, although it is fair that the company should have time to earn and pay to itself this amortization fund out of the earnings of the company.

The Marine Lighting Equipment of the Panama Canal*

The Panama Canal will be lighted throughout by automatic unattended lights, each having a distinctive characteristic. At the entrances and through Gatun Lake a double row of about 60 automatic acetylene lighted buoys will mark the channel. The channel will be further defined by powerful, rapid-flashing range-lights, one set at either end of each successive tangent.

The use of oil as an illuminant for lighted buoys is now obsolete, and the electric light is yet quite impracticable for this purpose, so that today buoys are lighted with gas only, either oil-gas or acetylene. In the case of the oil-gas buoy, the nature of the illuminant renders its light weak and inefficient unless aided by an incandescent mantle, which, of course, is an added source of unreliability to be avoided. Oil-gas also loses a considerable amount of illuminating power by compression, owing to condensation of the heavy hydrocarbons.

Acetylene, a product of recent years, is, in this country, rapidly superseding oil-gas, its properties rendering it especially well adapted for buoy lighting. Burned in a self-luminous burner without the use of a mantle the flame of acetylene gives an intensely concentrated white light. The illuminating power of pure acetylene is five times that of the richest oil-gas, and its efficiency remains unchanged by compression.

For buoy lighting acetylene must be perfectly dry and of absolute purity. As generated from ordinary commercial carbide, it contains moisture and impurities which, if not removed, would rapidly clog the flashing mechanism or carbonize the burner. The earliest type of buoy using acetylene as an illuminant is the "carbide buoy," a Canadian invention, in which calcium carbide is stored in a receptacle having free access to the surrounding water. This buoy has the objection previously cited, namely, that the gas thus generated is not dry nor sufficiently purified for the proper and continuous functioning of the burner and flasher. This fault, combined with its inherent wastefulness, has gradually led to the abandonment of the carbide buoy in favor of the simpler and more efficient type, using dissolved acetylene, and now adopted for lighting the Panama Canal.

THE BUOYS FOR THE PANAMA CANAL

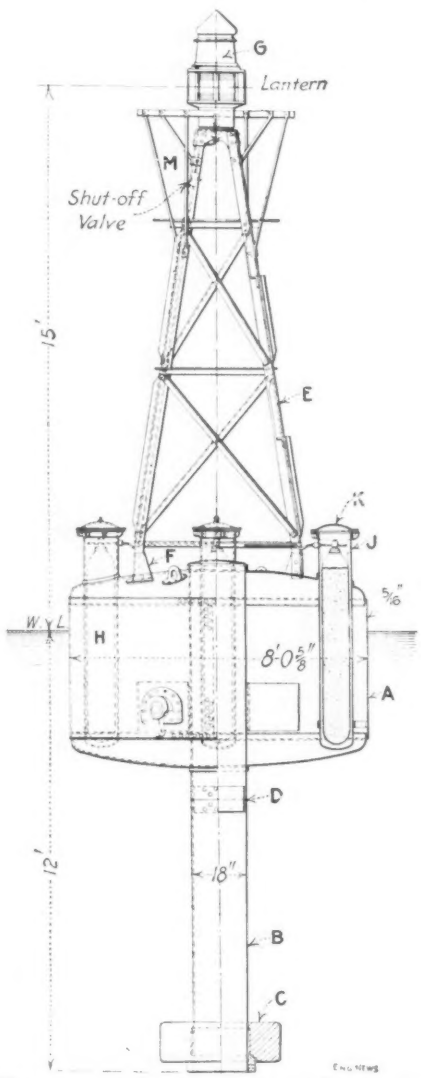
On following page is shown an elevation of the Panama buoy, in which A is the cylindrical body or chamber, 8 ft. in diameter, made of $\frac{5}{16}$-in. steel plate with dished heads riveted

*Abstract of a paper by James Pattison, of the American Gas Accumulator Co., read before the meeting of the Society of Naval Architects and Marine Engineers.

on. Through the center of the body passes the tube B, to which is bolted the counterweight C. This tube is made in two pieces, as indicated at D, for convenience in ocean transportation. The pyramidal skeleton tower E is bolted to the cast-steel foot-brackets F, and carries the lantern G at a focal height of 15 ft. The draft of the buoy is 12 ft. and the total weight without anchor chain 10,500 lb. Before painting and shipping the buoy is subjected to a hydrostatic test of 15 lb. per sq.in.

With reference to the gas supply and lighting apparatus, H represents the accumulators, of which there are four, filled with dissolved acetylene and inserted in the pockets J, which latter are furnished with hinged covers K for facilitating the removal and renewal of the accumulators. G is the lantern containing the pressure regulator or governor, as it is termed, and the flashing mechanism. The high-pressure gas is led from the accumulators to a manifold L, thence up the leg of the tower E, and through the shut-off valve M to the governor. The gas-piping is of special manufacture, made of solid drawn steel, 8 mm. outer diameter by 4 mm. inner diameter, with an outer protecting envelope of copper drawn thereon, which renders it completely rust-proof.

The best materials and processes are employed for preserving the buoy from the severe corroding action of sea-water and sea-air. The entire inside of the buoy is first given one coat of bitumastic solution applied cold, and then one coat of bitumastic hot in accordance with the manufacturers' formulas and processes. The exterior is given one coat of boiled linseed applied hot and two successive coats of best quality red lead mixed with best quality of boiled linseed oil.



ELEVATION OF ACETYLENE-LIGHTED BUOY FOR MARKING THE CHANNELS OF THE PANAMA CANAL

METHOD OF STORING GAS

The system of storing acetylene in portable accumulators is known as Dissolved Acetylene and is based upon the properties of acetone in combination with a suitable porous substance. To Claude and Hess, two French chemists, is due the important discovery that acetone, a combustible organic liquid which boils at 56° C. (133° F.), possesses an extraordinary capacity for dissolving acetylene. At 15° C. (59° F.) a given quantity of acetone will absorb 25 times its own volume of acetylene at normal atmospheric pressure, and its solvent capacity is increased proportionately to the pressure, so that at a pressure of 12 atmospheres it can absorb 300 times its own volume of acetylene.

Important as this discovery was, it was not directly adapted for practical use. When absorbing acetylene, the liquid expands at the rate of about 4% of its volume for each added atmosphere of pressure. Accordingly, a vessel intended for acetone saturated with acetylene under pressure can in practice never be entirely filled with liquid. During consumption, there would gradually be formed a space which would become filled with gaseous acetylene compressed above its limit of safety. This danger was completely obviated by the invention of the porous substance described in the succeeding paragraph and thus the illuminant, dissolved acetylene, was made available for practical use.

If a gas in a state liable to spontaneous dissociation or explosion is stored in a vessel whose diameter is less than that in which the explosive wave can be propagated, it is impossible to produce an explosion. Advantage has been taken of this fact by filling such vessels with a very porous material, the minute crevices of which are almost of insensible magnitude. In a vessel prepared in this way it is quite impossible to produce an explosion. This fact has been demonstrated beyond doubt by a variety of tests, and is practically recognized by the permission now granted in all countries for the use of compressed acetylene in vessels prepared according to this method.

The first condition with regard to the porous substance to be used is that it shall completely fill the vessel, leaving no space excepting the capillary canals formed by the substance itself. Other practical requirements are that it shall be perfectly free from action upon the acetylene or the acetone, that it shall possess a maximum amount of porosity, and that its consistency shall remain unaltered.

THE GAS ACCUMULATOR

The accumulators are prepared in accordance with these principles. More specifically described, an accumulator is a steel cylinder tested to at least 50 atmospheres pressure (the type used on the Panama buoys, which is the most common size, is tested to 75 atmospheres), and completely filled with the porous mass, a solid material possessing a porosity of 80%. That is to say, although the cylinder is apparently filled quite full, only 20% of the space is really occupied by the solid body, the remaining 80% being available for holding the liquid. Half of this remaining space is occupied by acetone, which soaks into every pore of the porous substance, the other half, or 40% of the original volume of the cylinder, is thus available for the expansion of the liquid. The cylinder is closed by a reliable valve, through which the gas is pumped into the accumulator, and through which it flows out again when required for service.

As the acetone charge is equal to 40% of the original volume of the cylinder, and the solvent capacity of acetone is 25 times its own volume per atmosphere of pressure, the acetylene storing capacity of the accumulator is, accordingly, 10 times its own volume for each atmosphere. Therefore, at a pressure of 10 atmospheres an accumulator contains 100 times its own volume of acetylene; at 12 atmospheres 120 times, and so on; this being computed for a temperature of 15° C. (59° F.).

INFLUENCE OF TEMPERATURE—A notable feature of dissolved acetylene is that its usefulness is independent of the temperature. Acetone will not freeze and the gas accumulator can therefore be used in the coldest climates. For example, more than fifty dissolved acetylene lights have been installed in Alaska and some of the installations operate the year round. It should, however, be observed that changes of temperature, although in no way interfering with the usefulness of the gas-accumulator, cause corresponding changes of pressure inside the accumulator. The solvent capacity of acetone varies according to the temperature in such a manner that while it amounts to 25 times its own volume at 59° F. (15° C.) it grows less at higher temperatures, so that at 122° F. (50° C.) it will be 50 per cent. less, that is, only 12½ times its own volume, whereas it becomes greater at lower temperatures, so that at about —4° F. (—20° C.) it will be double, that is, 50 times its own volume. With a given quantity of gas in an accumulator, the change in the solvent capacity at various temperatures will reveal itself by corresponding variations in the pressure; when the temperature rises the pressure will gradually rise, so that at 122° F. it will be twice as much as at 59° F.; when the temperature falls the pressure will gradually decrease so that at about —4° F. it will only be half of what it was at 59° F.

UPKEEP OF ACCUMULATORS—It will be readily understood that the accumulator is not a delicate thing. It will endure rough treatment or careless handling in transit. The strong steel cylinder cannot be easily dented. The valve is protected during transport by an iron cap. Inside, the iron is not affected either by acetone or by acetylene; outside, it only requires occasional painting to keep it from rusting. Neither will the porous mass cause trouble or require repair. As already stated, it has stood the test of time and, like the steel cylinder, it possesses practically unlimited durability. On the other hand, the acetone filling from time to time requires small additions. Minute quantities of it escape with the gas, and this loss will be noticeable after the accumulator has been recharged with gas a number of times. The acetone will be replenished, when necessary, at the government gas-charging station which it is understood will be located at Balboa at the Pacific entrance of the canal. These additions of acetone are made at an almost infinitesimal cost per accumulator and in connection with the foregoing it should be stated that the admixture of acetone vapor with the acetylene by no means detracts from the light efficiency of the gas, but in reality is of considerable practical value, as it causes the acetylene to burn more smoothly and

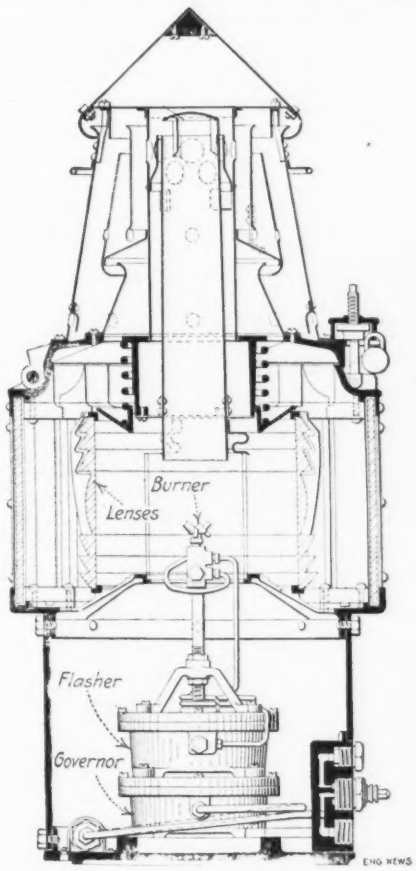
keeps the burner cooler. Replenishing of the acetone at intervals, together with occasional painting, are the only items of upkeep connected wtih the gas accumulators.

LIGHT APPARATUS

From the foregoing it will be seen that acetylene is stored in the accumulators under varying degrees of moderately high pressure while at the burner, a constant low pressure is required. Therefore the gas must be passed through a pressure regulator or governor, to reduce the high pressure to the required low constant pressure. The governor is the apparatus used for this purpose. Irrespective of the gas pressure in the accumulator, whether high or low, and of the gas consumption, whether large or small, the gas always issues from the governor at the constant low pressure suitabie for the burner..

THE FLASHER—An entirely new principle in flashers permits the production of as many as 55,000 separate and distinct flashes from one cubic foot of acetylene. Older types of apparatus could not produce more than 1400 flashes from the same quantity of gas. The new flasher may be adjusted to give light periods of any desired length of time down to one-tenth of a second, or less, alternating with dark intervals of any desired length. Single, double or triple flashes, etc., can be produced with ease, in fact, any light character obtainable in lighthouses equipped with the most modern lens arrangements can be produced by the new flasher.

For lighting the gas as it flows out of the burner during the light periods, a special pilot burner is used. This continuously burning pilot flame consumes only $\frac{1}{8}$ of a cubic foot of gas an hour, or about one-third of a cubic foot per day, as compared with six cubic feet per day in older acetylene flashers.



ELEVATION OF LANTERN WITH FRESNEL LENSES FOR PANAMA CANAL BUOYS

The method of operation of the new flasher may be described as follows: the gas issuing from the governor passes into the flasher, through a valve which remains open during the whole dark interval. When a certain predetermined quantity of gas has flowed through the pipe into the flasher, so that the flexible leather diaphragm is at the top of its stroke, the inlet valve instantaneously closes, and simultaneously the outlet valve to the main burner opens, allowing the accumulated gas to pass through the pipe to the main burner where it is ignited by the constantly burning pilot flame. The pilot flame is fed through the bypass direct from the governor. The valve lever is magnetized so as to always maintain a tight joint with the valve seats and to produce the desired instantaneous cutoff. The gas outlet now remains open until the total gas quantity has been consumed in the main burner, whereupon the outlet closes and the inlet opens, remaining open until a similar quantity of gas accumulates within the flasher, when the cycle of operations is again repeated. Thus the light and dark intervals alternate automatically and produce a uniform flashing light. The pressure of the gas flowing from the flasher to the burner does not vary during the entire light period, regardless of the duration of such period. In the older makes of flashers, the gas enters the burner at a low pressure, which gradually rises to the maximum and falls again toward the end of the flash, thus wasting gas and making it difficult at long ranges to determine exactly the characteristic of the light.

LIGHT CHARACTERS—The principle of the flashing light as a valuable navigation signal has been taken advantage of in the highest degree by designing the new flasher to consume the least possible amount of gas per flash and to make the dark intervals when no gas is being consumed as long as is consistent with efficiency. It is naturally of the utmost importance for the safety of navigation that the light character (the ratio between light and eclipse) after having once been fixed must not vary in the slightest degree. Nearly all lighthouse authorities agree that flashes of short duration followed by relatively short, dark periods are much more distinctive and efficient than long flashes, and this view is borne out by the fact that, of the thousand or more dissolved acetylene lights in operation throughout the world, the majority are adjusted for short flashes. Of the light characters adopted by the army engineers for the lights on the Panama Canal, the flashes do not in any instance exceed 2 seconds' duration, and the majority of them will be set to 0.3 of a second.

The new flasher, although designed especially to suit short flashes, may easily be adjusted to give flashes of any desired length.

THE BUOY LANTERN—The Panama Canal buoys will all be equipped with sixth-order lanterns. This method of dividing lighthouse lanterns into various orders is based upon the focal distance of the optic, that is, half the diameter of the lens at the focal plane. The data for this method of classification are given in the following table.

Order	Focal distance mm.	Diameter of lens mm.
Hyper-radial	1330	2660
First order	920	1840
Second order	700	1400
Third order	500	1000
Third order (small type)	375	750
Fourth order	250	500
Fifth order	187.5	375
Sixth order*	150	300
Seventh order	100	200

With a 1-ft. burner (the size adopted for the Panama buoys), the efficiency of the light through the lens will be 400 Hefner cp. visible at a range of about 11¼ nautical miles. Such great candle-powers are obtainable on account of the high intrinsic brightness of the acetylene flame, which, being relatively small in size, permits of almost exact centering at the focus of the lantern lens.

DISCUSSION

In the discussion of this paper, H. A. Gillis, of the Safety Car Heating & Lighting Co. (Pintsch system), gave the average life of mantles on 2003 buoys as three months and noted that the loss of candlepower due to compression was about 10%. He gave the following figures for illuminating value: Acetylene (purified), 40 cp. per cu.ft. burner capacity; acetylene (dissolved in acetone), 38 cp. per cu.ft.; Pintsch gas (compressed to 12 atm.) in flat flame regenerative burner, 12 cp. per cu.ft.; Pintsch gas under large mantles at 2 lb. pressure, 60 cp. per cu.ft., and under small (buoy) mantles at 1 lb. pressure, 40 cp. per cu.ft.

The statement that the carbide-type of buoy had been abandoned was questioned, since the Canadian government uses nothing else yet, and the U. S. Government is still experimenting with them and has one at the outer end of Ambrose Channel in New York Harbor. There were cited as here, also six compressed-acetylene buoys, and 12 Pintsch-mantle buoys. In the Gedney channel are 12 Pintsch buoys; in the Delaware River are ten Pintsch and one compressed-acetylene buoys. The gas in the compressed-acetylene Ambrose-channel buoys (flashing 0.4 sec. light and 0.8 sec. dark with 40-cp. burner taking 300 cu.ft. per mo.) costs $4.50 per mo. The Pintsch buoys (fixed light with 30-cp. burner taking 630 cu.ft. per mo.) costs $3.30 per mo. plain or $3.45 with a mantle.

The statement of complete safety for dissolved acetylene in a porous holder was questioned by citing the number of actual explosions including one in which the patentee of the acetylene system described and two assistants were severely injured.

The flasher was claimed to be designed on the same lines as older apparatus except that coil springs had always been used instead of the magnets seen here. It was declared that mariners favored equal periods of flash and darkness, to satisfy which would reduce the service capacity of the Panama buoys to six months.

The design of lamp was criticized as weak, the vertical astregals not having the strength or rigidity of helical bars and triangular storm panes. It was claimed that not over 10% of the light was absorbed by the helix, while the loss of light by absorption of reflecting prisms equals that of the helical astregal.

Derrick Cars and Wrecking Cranes for Electric Railways

The equipment of nearly all electric railways, whether city or interurban, includes derrick cars and cranes for handling materials at the yards or on construction and maintenance work, and also for handling wrecked or derailed cars. Some examples of machines of this class are described below.

Derrick Car for the Third Ave. Ry., New York

The derrick car shown in Fig. 1 is of a rather unusual type, and consists of a steel-frame flat car carrying at one end a pillar crane having a horizontal boom upon which travels a hoisting trolley. The motorman's cab, with a bracket for the trolley-pole seat, is at the opposite end of the car, but the car can be operated from either end. The boom is of 20 ft. 8 in. radius, and the hoisting trolley has a capacity of 6 tons, with a maximum reach of 18 ft. and a lift of about 9½ ft. from the rail to the highest position of the hook. The derrick is handled by a man riding in a cage at the side of the boom. The hoisting is done by a motor of 11 hp., giving a speed of 13 ft. per min.; the cables for racking the trolley along the boom are operated by a 3 hp. motor, giving a speed of 40 ft. per min. A similar motor swings the crane at the rate of one complete revolution in 40 seconds.

To steady the car when making heavy lifts there is a 20-ton jack-screw under each corner of the car at the crane end. These jacks have the heads secured by pins to brackets under the sills and are swung up out of the way when not in use. The car can be used for transporting track material, paving blocks, broken stone, etc., the sides being fitted with removable sideboards to retain loose material. This machine was built by the McGuire-Cummings Mfg. Co., of Chicago, and is part of the equipment of the maintenance-of-way department of the railway.

The frame has side sills consisting of two 15-in. steel channels, riveted back to back (forming an I-section), and having top and bottom cover plates. Only one channel of each sill, however, extends from the front bolster to the end sill, under the cab. The body bolsters and end sills are of steel channels, and 6 in.-channels, framed between the sills, carry wood joists 4x6 in., to which the 2-in. floor planks are spiked. Five wearing strips of longitudinal flat steel bars are let into the floor. The removable sides are 2 ft. high, and in four sections 7½ ft. long, each section consisting of two planks secured to two inside T-bar stakes, which are bent to fit pockets inside of the sills. The car is 40 ft. long and 8 ft. 3 in. wide over the sills, with trucks of 4½ ft. wheelbase spaced 21½ ft. between centers.

Derrick Car; Brooklyn Rapid Transit Ry.

The derrick car shown in Fig. 2 is of a type more commonly used than that described above, and has a revolving crane with steel inclined boom whose reach can be varied by means of a topping lift. The boom is 18 ft. long, with a working reach of 20 ft. from center of car, and a maximum height of 20 ft. above the rail. Since the machine was built, a snatch block has been fitted near the middle of the boom, and the hoisting line is led back from the head sheave over this snatch block, so that for an ordinary reach the load is carried farther back on the boom. The hoisting capacity is 5 tons, and the hoist is operated by a 24-hp. motor giving a speed of 40 ft. per min., with maximum load. The capacity varies from 2½ tons at 20 ft. radius to 5 tons at 11 ft. radius. All motions for hoisting, swinging and topping are controlled by the operator riding in the cab of the crane.

The car is 40 ft. long and 7½ ft. wide, with trucks of 5½ ft. wheelbase, spaced 20½ ft. centers. For propelling, the car is fitted with four 40-hp. motors. The side sills consist of 10-in. channels, each reinforced for the greater part of its length by a 7-in. channel on the inner side. The frame is stiffened by a pair of truss rods which pass over the bolsters and have their ends anchored to cross-braces beneath the sills. The weight of the car complete is about 30 tons. The machine was built by the Brown Hoisting Machinery Co., of Cleveland, Ohio. It is used for handling rails and special work, both at the storage yards and on the track.

Derrick Car; Northwestern Elevated Ry.; Chicago

In derrick cars for track-repair work, built at the company's shops, the derrick is immediately behind the cab. The timber boom is 20 ft. long, guyed from a post and A-frame not much higher than the cab. The hoisting line is operated by a 12-hp. motor, but the swinging is done

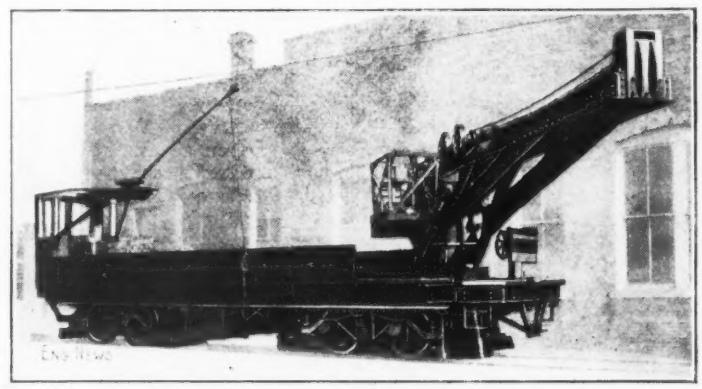


Fig. 1. Electric Derrick Car of the Maintenance-of-Way Department, Third Ave. Ry., New York
(McGuire-Cummings Mfg. Co., Chicago, Builders.)

by hand lines. The topping lift is not generally used, and is worked by hand or by carrying the line to a winch head on the hoist.

The motorman operates the hoist as well as the car movements, and in running position he faces the derrick. The trucks are equipped with powerful motors so that the car can keep out of the way of regular trains, running to the nearest crossover when necessary to allow a train to pass. The car is of timber construction, 46x8½ ft., with a 9-ft. cab at one end. Stakes are fitted to pockets on the side sills to support side boards when carrying loose material. The car is equipped with both contact shoes and trolley poles so that it can operate on the third-rail elevated lines and also on the overhead-wire system of the company's surface lines.

Wrecking and Yard Cranes; Illinois Traction System

The larger electric lines need equipment for handling cars, etc., in case of derailment or other accidents, and in most cases the derrick cars are utilized for work

of this kind. The Illinois Traction System, however, has a wrecking crane or wrecking car equipped with a boom of special shape for the handling of cars and car bodies. This is shown in Fig. 3, and it will be seen that the machine resembles ordinary wrecking crane practice, having a steel-framed platform mounted on a pair of trucks and carrying a revolving crane. But in this machine all movements (including propulsion) are effected through

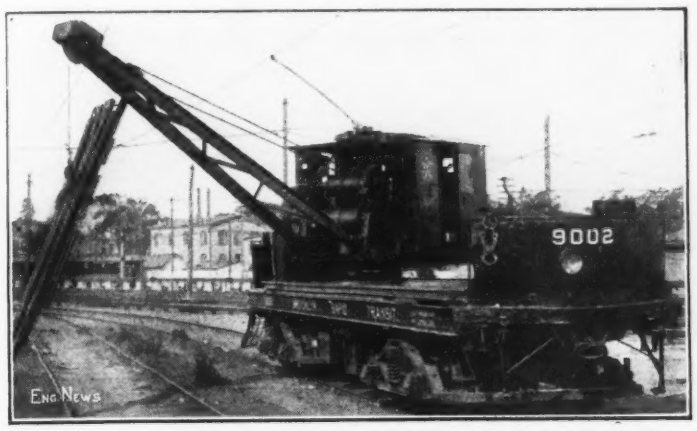


FIG. 2. ELECTRIC DERRICK CAR OF THE BROOKLYN RAPID TRANSIT RY., BROOKLYN, N. Y.
(Brown Hoisting Machinery Co., Cleveland, Ohio; Builders.)

bevel gears instead of chain gearing. Power is supplied by an electric motor of 100 hp.

The car is 13 ft. 6 in. long and 9 ft. 10 in. wide, with a 30 ft. goose-neck boom; and weighs about 65 tons in working order. It can lift 11½ tons at maximum reach and has a maximum hoisting capacity of 30 tons. It can hoist also at a distance of 20 ft. below the track. In addition to the main hoisting block, there is an auxiliary hoisting cable on the head sheave of the boom. The topping-lift cables pass over pulleys on long arms pivoted to pins in a bracket on the back of the boom, as shown.

A practically identical machine for work in the storage yards, etc., has a straight box-lattice boom 46 ft. long, with a hoisting capacity of 4 to 17 tons and a reach of 30 ft. below the rails. This machine is used also in handling coal from the submerged storage pits, and for this work it operates a 1½-yd. clamshell bucket. Both of these machines were built by the Browning Engineering Co., of Cleveland, Ohio, to meet the requirements of J. M. Bosenbury, Superintendent of Motive Power of the railway. The electrical equipment is the same in both cases. The hoisting, swinging and propelling motions are all operated from one 650-volt 90-hp. motor, by means of a train of bevel gears. The controllers are of the reversible type, and there are 200-amp. fuse boxes and two 150-amp. circuit breakers. Both air brakes and hand brakes are applied.

FIG. 3. ELECTRIC WRECKING CRANE OF THE ILLINOIS TRACTION SYSTEM
(Browning Engineering Co., Cleveland, Ohio, Builders.)

LARGE STEAM WRECKING CRANES

Of a rather different class from the machines above described are some new wrecking cranes on the Norfolk & Western R.R., which have a hoisting capacity of no less than 150 tons. The platform of the car is 27x10 ft., of steel construction, mounted on a pair of four-wheel trucks, giving a total wheelbase of about 20 ft. To steady the machine for a side lift or on soft ground outriggers of steel I-beams can be extended about 7 ft. on each side. The plate-girder boom is attached to the end of a swinging platform which carries the engine and boiler, the platform being mounted on a turntable of large diameter. The boom is only slightly curved, and the distance from its heel to the topping lift attachment is about one-third of the length of the boom. The main hoist is at a distance of 17 ft. from the center of rotation, and there is another hoist at the extreme end of the boom. The maximum load (150 tons at a radius of 17 ft.) can be raised at a speed of 15 ft. per min., and the boom can be raised or lowered by the topping lift while carrying this load. The weight of the machine in working condition is about 120 tons. The cranes were built by the Industrial Works, Bay City, Mich.

⁂

Progress of Excavation in Culebra Cut, Panama Canal—Excavation has advanced to the point where there is only about 8000 lin.ft. of distance left, exclusive of the drainage channel, in which the prism has not reached grade in some part. This section is confined to that part of the cut between the Cucaracha slide, and the northern limit of the slide on the east bank, opposite Culebra village. Between Gold Hill and Contractor's Hill, a part of the drainage cut is down to grade, and visitors are now able to get a fairly clear conception of the final depth of the summit cutting.

On Mar. 29, there were 32 steam shovels working in the canal prism in the Culebra cut section; 13 of these were working on slide material, and the remainder in removing material at the bottom. This number is exclusive of the steam shovels engaged in terracing the banks, and in miscellaneous operations. At the present rate of progress, it is estimated that about 5,500,000 cu.yd. of material may be removed by Oct. 1, the date at which operations by steam-shovels will probably be suspended. This leaves between 2,000,000 and 3,000,000 cu.yd., based upon the recently revised estimate, that will have to be taken out by dredges if the water is let into the canal on Oct. 1. The amount to be removed in this manner will probably be increased by slides at different points along the banks between now and the end of the year.

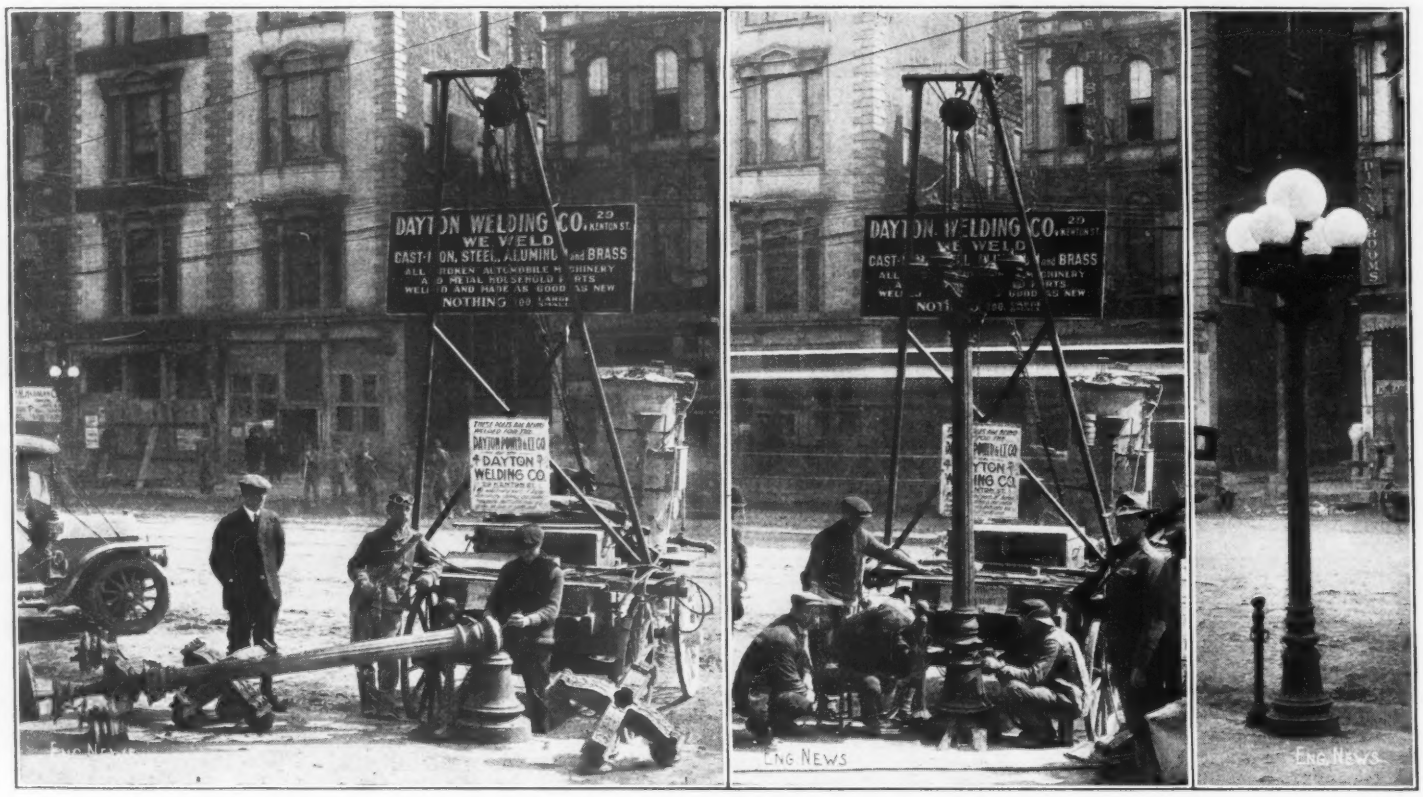
Work on the Cucaracha slide is progressing favorably, and the output from it has been increasing day by day for the past month, or more, the record output being made on Mar. 29, when five steam shovels removed 11,343 cu.yd. of material. This is the largest amount of excavation from a single slide in one day since the beginning of operations by the United States. The rock shoulder that formerly stood out prominently from this slide for two or three years before it renewed its activity, and which appeared to offer a stay to the mass of material behind it, joined the new movement, and has now moved into the canal for a distance of about 80 ft.

On Apr. 14, several of the steam-shovel crews were put to work on a 12-hr. shift. ["Canal Record."]

FIELD AND OFFICE

Oxyacetylene Welding and Cutting Operations

REPAIRING LAMP POSTS IN DAYTON—During the recent floods in Dayton, Ohio, about 150 of the ornamental cluster lamp poles were broken off about 18 in. above the ground. The breaks were not due to defective castings but due to heavy objects being swept against the poles by the current through the streets. When the question of welding these poles, instead of erecting new ones, was first brought to the attention of the Dayton Power & Light Co., the officers of the latter did not think it possible to secure the required strength at the welds, since all of the work had to be done on the street. To take up the concrete and to reset the poles would have been a very expensive operation.



FIGS. 1, 2 AND 3. WELDING ORNAMENTAL LAMP POSTS IN DAYTON, OHIO.
(Fig. 1, preparing the joint; Fig. 2, welding the broken edges; Fig. 3, the pole completed.)

To demonstrate the possibilities of this sort of repair, six specimen poles were welded and tested, when it was found that they were as strong as new. They were probably stronger at the point of weld, as a ⅛-in. fillet was added on the outside during the process. The operations of making these repairs are shown in Figs. 1 to 3. A special derrick was fastened to the rear of the wagon which also carried the acetylene generator, the oxygen tank and the necessary tools. The wagon was backed up to the stub of each pole, and the broken part was raised to its original position; the old breaks were matched up and the joints were prepared for welding. No trouble was found in keeping the poles in alignment during the work. It is reported that this particular sort of perpendicular weld is considered by the workmen to be one of the most difficult manipulations, and many experienced men will not attempt it.

With the one portable outfit shown, and employing three men, the contractors were able to erect six to seven poles per day at one-half the cost of new poles, not including the probable cost of removing the broken stubs, resetting new poles and replacing the concrete about the bases. The work was done by the Dayton Welding company. We are indebted to Mr. W. L. Blackwell, president of that company, for the information and photographs presented.

REMOVING WRECKAGE IN INDIANAPOLIS—Fig. 4 shows the use of an oxyacetylene cutting torch in use in removing the wreckage of a reinforced-concrete arch-span bridge in Indianapolis, Ind. Two important bridges were wrecked during the recent flood (ENGINEERING NEWS, Apr. 17 and 24, 1913). One was of concrete, faced with stone, and reinforced with I-beams, which hung between piers as strings of twisted junk. The wreckage of a plate-girder bridge with concrete floor was equally troublesome.

Tanks of dissolved acetylene and oxygen were mounted on trucks, hauled to the bridges and used with cutting torches. First, the I-beams were locally heated to a bright red, as shown in Fig. 4, and then a stream of pure oxy-

FIG. 4. CUTTING AWAY I-BEAM REINFORCEMENT OF WRECKED MERIDIAN ST. BRIDGE, INDIANAPOLIS

gen was directed against the hot metal. This caused the iron to burn away quickly so that the average time consumed in serving a beam was a little over five minutes. The work of cutting the beams and girders of the two bridges and placing them in a position for easier removal took a little over three days. The work was done by the Prest-O-Lite Co., makers of portable acetylene lighting systems and welding outfits.

Effect of Too Much Water in Mixing Concrete

In connection with the discussions as to the relative desirability of wet and dry concrete current some years ago a number of tests were made on concretes containing varying degrees of mixing water, but most of the tests had a maximum of 20% of water, that being then about the limit of wetness in practice. Of late, however, with the advent of much slushier concrete, doubt has been thrown on the ultimate strength and wearing qualities of the very wet mixes which have become common. As a contribution to this question, we present below the results of a limited test on the short-time strength of concretes mixed with percentages of water, varying from 20 to 42½%. The tests were made in the Sheffield Scientific School of Yale University, by Charles J. Robison, who prepared the accompanying tables and diagram.

The tests were made on a 1:2:4 concrete mixed with normal sand, cement and ¾-in. trap rock, cast as small beams and as cubes and broken in bending and in compression, respectively. The beams were 2x3½x36 in. in size, reinforced with two ⅛-in. rods in the lower part of the section, and designed to carry safely a load of 274.2 lb. placed at the center. The cubes were 6 in. on a side. The specimens were kept in the forms for 48 hours and kept moist for 10 days (except the 7-day cubes) and were tested up to a 60-day age, as shown by the accompanying tables and figure.

All material was dry before mixing and water was added in percentages from 20% to 42½%, according to the following method: As a minimum, enough water was taken to moisten the stone and sand, and then there

TABLE I. BREAKING LOAD ON REINFORCED-CONCRETE BEAMS MADE WITH VARIOUS AMOUNTS OF MIXING WATER

(Center load in pounds)

[2 x 3½ x 36 in. beams, reinforced with two ⅛-in. rods, 1 : 2 : 4 concrete]

% Water	30-day Test*	60-day Test*
20	290 (1)	300
22½	368 (2)	410
25	473	550
27½	637	680
30	507	560
32½	461	500
35	418	450
37½	360	400
42½	313	340

* Average of three tests except as shown in parenthesis.
† One test only.

TABLE II. COMPRESSION VALUES (LB. PER SQ.IN.) ON 6-IN. CONCRETE CUBES WITH VARYING PERCENTAGES OF WATER

	7 days†	30 days*	60 days†
20%	2052	2777	3194
22½	2173	3132	3305
25	2277	3278	3388
27½	2500	3516	3597
30	1722	2874	3166
32½	1413	2416	2666
35	1222	1977	2388
37½	1097	1819	2173
42½	652	1500	1888

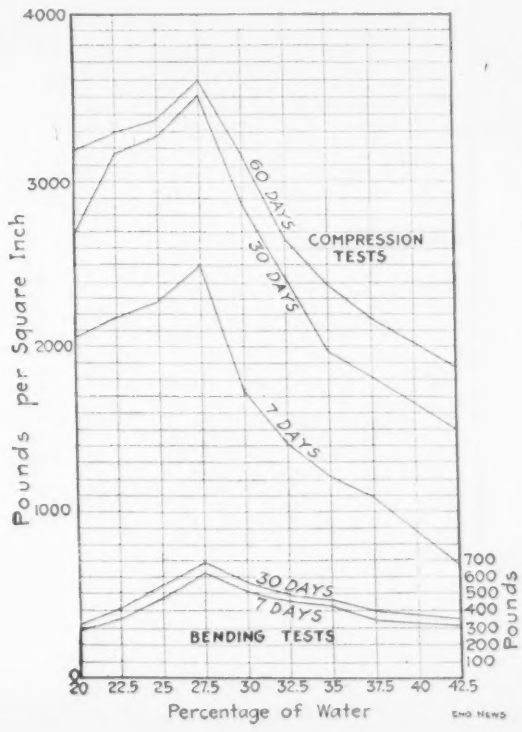
* Average of two tests.
† One test only.

was added 20% (of the amount of cement by weight) water. Each subsequent mixture was increased by 2½% water. It was noted that the 42½% mixture was about as wet as is used in the average wet mixer, though dryer than some slushy mixes.

Table I shows the results of the beam tests. It may be noted that keeping everything constant except the water, there is a gain in strength of 126% for a 27½% over a 20% water content at the end of 30 days, and 126⅔% at the end of 60 days. Although all the beams carried their designed load, in some cases the factor of safety is very small, particularly in the 42½% mixture, which is commonly used in practice.

Table II gives the results in the cubes; practically the same as on the beams. There is a gain of 282% with the 27½% water content over the 42½% at seven days, 138% at 30 days and 90% at 60 days, which may indicate that in time a drying out will take place sufficient to reduct the handicap of the very wet mix.

The accompanying curve is a graphical representation of the data in Tables I and II.



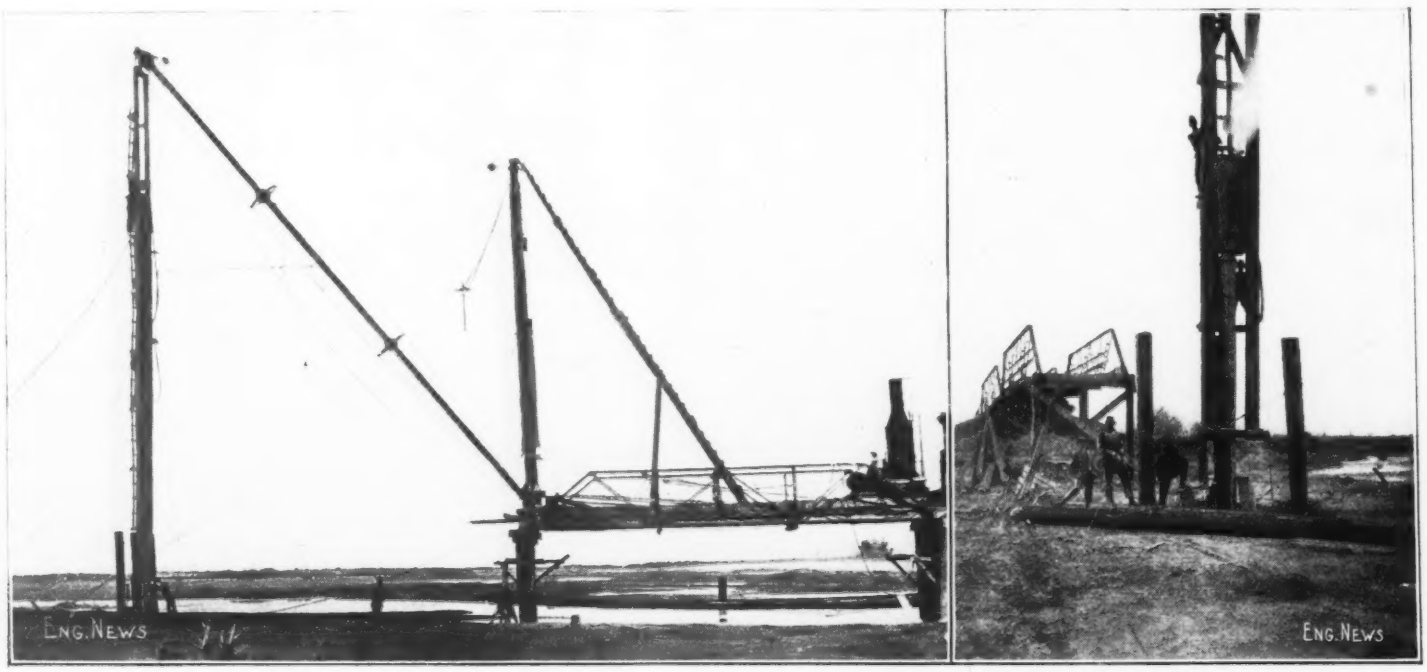
Bridging a River in Quicksand

In building light highway bridges over the Rio Grande at El Paso, Tex., pile bents were used as substructure. Driving the piles required a special rig, because the river bed is quicksand from bank to bank and therefore ordinary methods of temporary staging for the piledriver could not be used. The rig shown in the two views below was built to handle the work.

A pair of swinging driver-leads with steam hammer is carried at the end of a derrick boom. The derrick and engine are mounted on a timber bed-frame 54 ft. long, set on rollers, traveling on the roadway of the finished spans. An overhang of about 50 ft. is obtained, which enables the next pile-bent ahead to be driven ready for the truss seat. The derrick then sets the span, previously assembled.

The piles were 60-ft. yellow pine piles, averaging 3000 lb. weight. A penetration of 52 to 58 ft. was required. The hammer used weighed 5500 lb. The leads used were 68 ft. long. The derrick had a capacity of 8 tons; the mast is 48 ft. high and the latticed-steel boom 80 ft. long. About one hour continuous driving was required per pile, the hammer striking 130 blows per min.

The El Paso Bridge & Iron Co. erected the bridges. W. E. Robinson, manager of the company, gives the above data.



DRIVING PILE BENTS FOR A BRIDGE FROM SPAN LAST ERECTED; EL PASO, TEX.

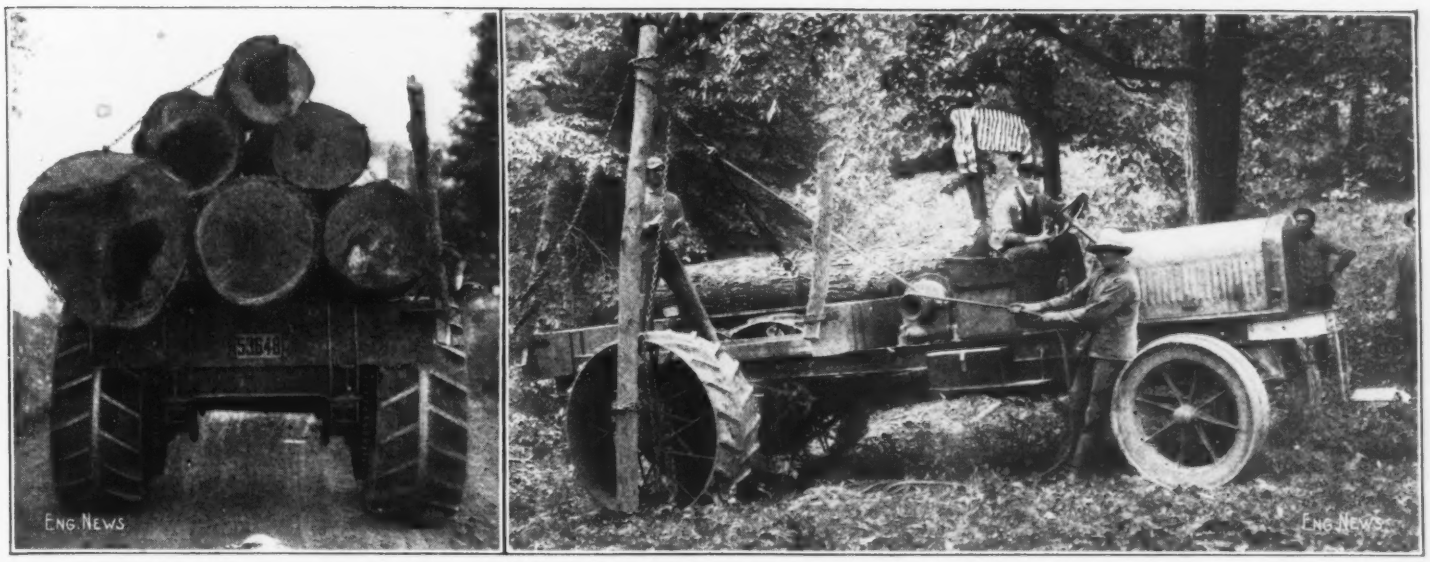
Motor-Operated Section-Cars on the Toledo & Ohio Central Ry.

For some years past there has been an increasing use of motor-operated cars for railway section gangs. They are found to have advantages in saving the time and energy commonly expended in "pumping" the hand-car to and from the work every day, and in enabling the length of the section to be increased (without increasing the force) owing to the greater speed and facility in getting over the work. We present below some information furnished by J. A. Stocker, Chief Engineer of the Toledo & Ohio Central Ry., in regard to experience with motor cars on that road.

In 1910 the company purchased two gasoline section cars for use where the section headquarters were at some distance from the section limits. The operation was carefully watched, and the results obtained were such that in 1912 it was decided to equip two light-traffic divisions with motor cars at all points, except in yards. These divisions had five-mile sections (the standard length on this road), and during the winter it had been customary to reduce forces to a foreman and two men on each section. This made the percentage of foremen high, and it was thought advisable to lengthen the sections to eight miles (except where track conditions prevented), and to make the minimum section force a foreman and three men. In June, 1912, 18 gasoline cars were installed on the two divisions, which have now sections 6 to 8 miles long. The grades range from 0.4% to 2.5%.

At each section headquarters, a small storage shed was constructed, this being placed a sufficient distance from other buildings to avoid danger from fire. An arrangement was made with an oil company to deliver gasoline by tank wagons. Each shed has a 30-gal. tank for gasoline, a 2-gal. can for lubricating oil, a 2-gal. measure to charge the car, a pint measure, and two funnels. This equipment cost $3.60. Each foreman is given a set of instructions, and is required to keep account of the fuel, supplies and repairs, and the number of miles run. He furnishes the supervisor with a performance report every month.

The results of the operation of 21 cars on 20 sections for the last six months of 1912 are summarized below. No charge has been made for inspection or for the labor of making repairs, as the inspection has been done by the manufacturer and the repairs by the foreman. For the future it is considered advisable to employ a repairman to make periodical inspection and repairs, with a view to standardizing the condition of maintenance of the cars and thus obtaining a more uniform performance. The records show wide variations in the cost per mile run, which bear no relation to the grades upon which the



A 5-Ton White Motor Truck with Power Winch for Logging Scattered Hardwood Timber

cars are operated, and it is thought these are due largely to the varying efficiency of the different foremen.

The average cost of fuel, supplies and repairs per mile run was 0.98c., with a minimum of 0.67c. (2418 miles run) and a maximum of 1.77c. (1312 miles). The latter was on a section having a 2½% grade. The miles run per car for the period mentioned ranged from 766 to 2816. The average mileage per car was as follows: miles run, 1653; 23 miles per gal. of gasoline, 345 per gal. of lubricating oil, 655 per lb. of grease, and 181 per battery cell. In computing this last, only those cars with battery ignition were considered. A few of the cars are equipped with magneto ignition and have given satisfactory results, but it is considered too early to determine which method is the better.

Among the principal advantages derived from the use of the motor cars are the following: (1) The men arrive at their work fresh and unfatigued; (2) less time is consumed going to and from work, the saving being estimated at 30 min. per day; (3) there is no disposition of the men to shirk before quitting time in order to rest for the long pull to headquarters; (4) if the supervisor desires to concentrate a number of gangs at one point, they are transported by the motor cars instead of by train. The question of safety of motor cars as compared with hand cars frequently arises. Usually while riding on hand cars, no one but the foreman is keeping a lookout for trains. While riding on the motor car, the men sit facing sideways; all are in position to watch for approaching trains and can readily jump off the car. Mr. Stocker says the indications are that motor cars are no more dangerous than hand cars, and that they are considered somewhat less dangerous. This experience has been entirely on single-track railway. He would not recommend motor cars for short sections, nor for lines with more than two running tracks.

Logging with a Motor Truck

The hardwood forests of Ohio and the Middle West, where Daniel Boone and other famous pioneers and Indian fighters used to ramble, are now mostly a matter of history, and whatever standing timber is left is scattered and not economically gotten out by ordinary means. The accompanying illustrations show how an enterprising lumberman of Cuyahoga County, Ohio, has solved the problem of lumbering these stray trees which have so long escaped the woodman's ax.

On a small scale the truck shown in the illustrations has done the work of a logging locomotive, skidder and donkey engine. A power winch driven from the transmission shaft is built near the middle of the truck body, and is controlled by a lever similar to those for the brake and transmission control. By a proper use of the winch and a simple rope-and-chain tackle the truck crew of four men has loaded 1000 ft., b.m., of timber in 20 min. The winch is made of further use in lifting logs out of gulleys and ravines and in unloading from truck to flat-cars.

The truck has a six-cylinder gasoline motor, and in all respects except the wheels is the standard 5-ton model truck made by the White Co., of Cleveland, Ohio. Both front and rear wheels are of special build. The driving wheels are steel with 22-in. treads corrugated in the maner of tractor wheels, which enables the truck to run over rough surfaces and on soft ground without serious difficulty even when away from all roads and paths. The front wheels are equipped with heavy ribbed steel tires.

Experience has proved that the truck can travel with its full load in practically all seasons of the year. The driving power is multiplied by the use of a gear ratio much lower than that used for trucks in normal service, which limits the speed to about 8 miles per hour.

While in no sense a rival of the logging railway for large-scale lumber projects, the truck has proved economical in culling fine specimens of oak, walnut, hickory and ash, which have hitherto been almost immune against the ordinary methods of getting out timber in such isolated groups.

A Suggestion for Small Cities—All cities of small size, or for that matter all cities, would do well to follow the example of Little Falls, N. Y., which puts this note in the Annual Report of the Board of Public Works:

The city is situated about in latitude 43° 0.03′ north, and longitude 74° 52′ west of the meridian of Greenwich. It embraces 2591.22 acres within the city boundaries. The lengths of streets and roads within the city limits approximate 25 miles. Population about 12,500.

Such data are often looked for, and hard to find. Elevation above sealevel might be added to the location data.

An Economical Sand and Gravel Plant

Perhaps few small engineering jobs offer better opportunity for originality in design and construction than the erection of a sand and gravel mining, screening, and sometimes washing plant. There are many ways of handling the material from gravel bank to the salable product in carts, cars or scows, and on the selection of equipment

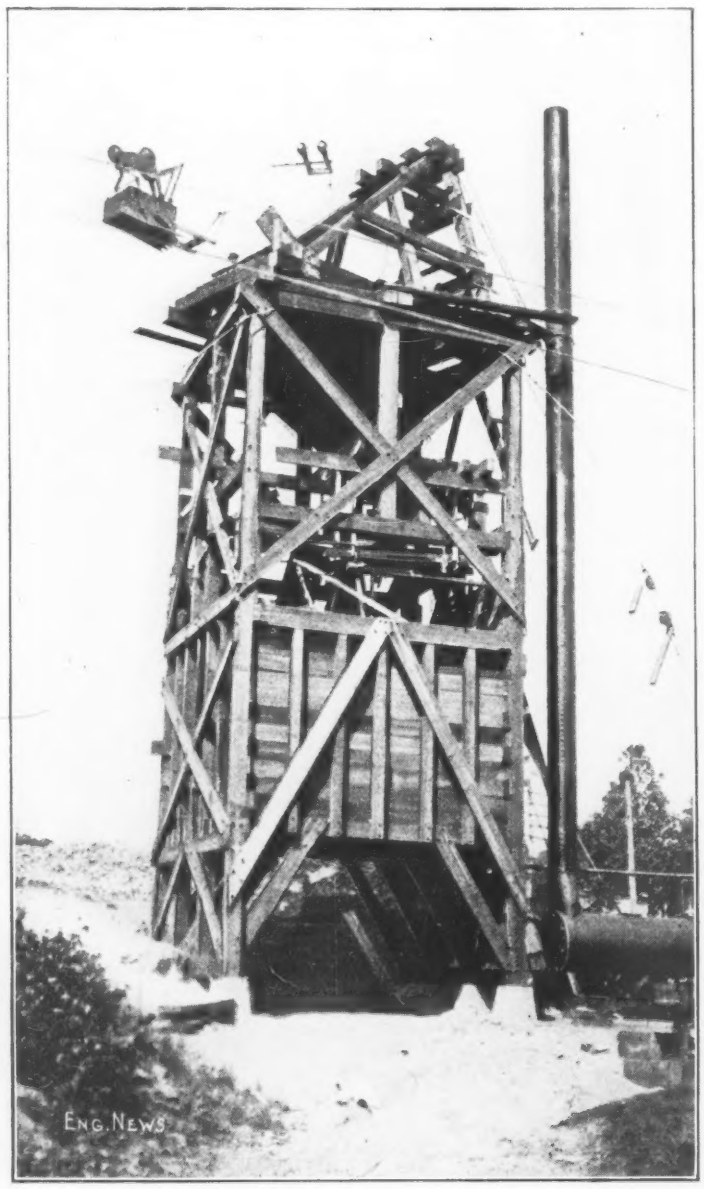


FIG. 1. SCRAPER-BUCKET EXCAVATOR AND SCREENING TOWER, WATERBURY SAND & GRAVEL CO.

best suited to the local conditions may depend the financial success of the plant.

The plant shown in the accompanying illustrations is located on a public highway in front of a gravel bank which, in general, has a downhill slope away from the roadway. Hence most of the sand and gravel has to be elevated not only the height of the tower, but up the sidehill as well.

The tower is 18 ft. square and 45 ft. high from ground level to base of quadrupod, or double A-frame, on top, and is guyed by wire rope from each corner. The corner timbers are 10x10-in. and the diagonal braces are 3x12-in. timbers. The top framework on which the quadrupod rests is built of 12x12-in. timbers. The quadrupod itself is made of 10x10-in. timbers and can be turned about a center pin so as to face in any direction. The bearing between the quadrupod and the tower framework is a 2-in. bar-iron circular track on which the steel-plated corners of the quadrupod rest.

The main 1-in. steel-wire cable on which the bucket travels is fastened to a dead man buried in the far end of the gravel bank. By moving this anchor to different positions it is clear that the cable may be hung over any part of the gravel bank. The main cable passes over a sheave in the top of the quadrupod to a pair of double-sheave blocks, the lower one of which is attached to another anchorage. The smaller cable from the pair of blocks passes over a sheave on the quadrupod and is wound on one of the drums of a 30-hp. hoisting engine located between the two A-frames of the quadrupod.

To the excavator bucket is attached a bridle and cable, which is wound on the other drum of the hoist, as with the ordinary cable excavator. By slacking off this draft cable the bucket is allowed to run down the incline of the main cable to any part of the bank; the main cable is then slacked off, and the bucket is filled by drawing up on the draft cable. The main cable is then tightened

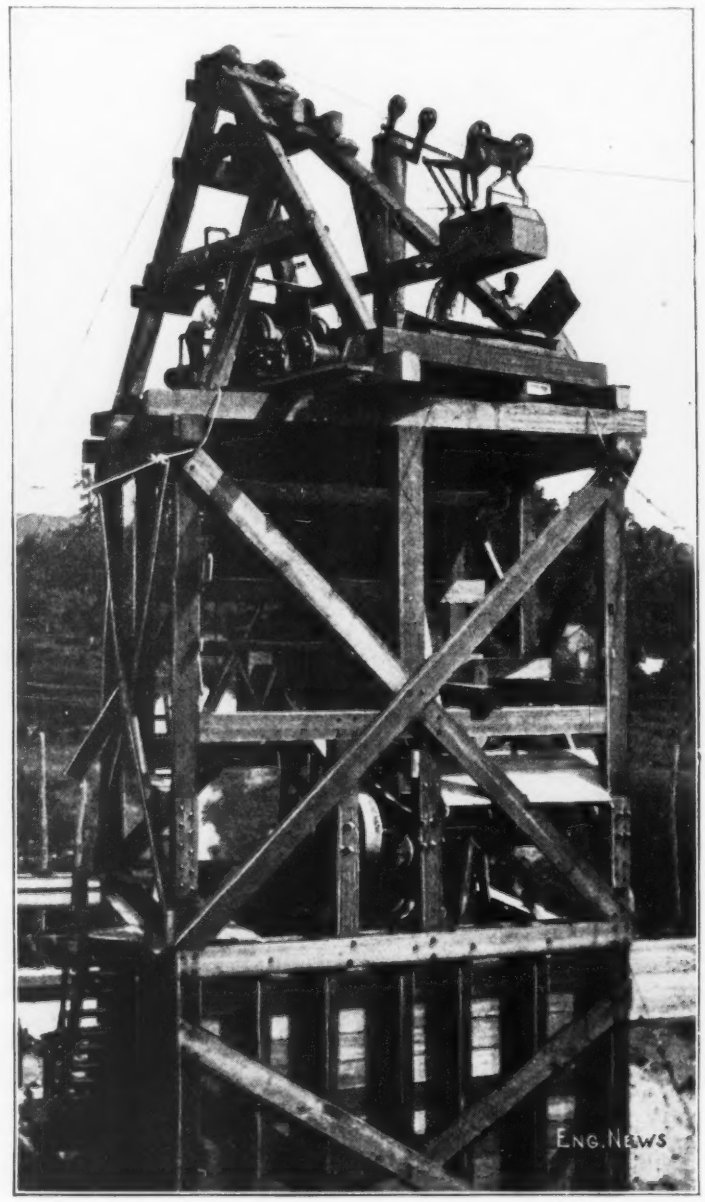


FIG. 2. VIEW OF TOWER, SHOWING ARRANGEMENT OF MACHINERY

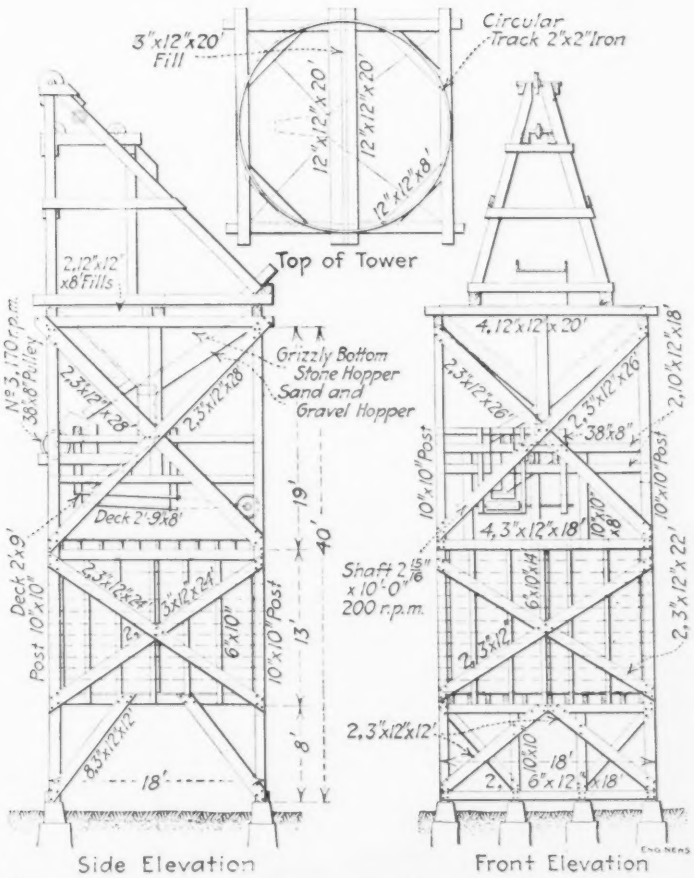


FIG. 3. DETAILS OF SAND AND GRAVEL SCREENING AND STORAGE TOWER

and the bucket run to the top of the tower where a trip automatically discharges the contents into a hopper.

Stones too big to pass the gravel screen are diverted to a small stone crusher which discharges to two shaker-screens below. The sand and gravel fall through a chute to the same screens. The shaker-screens are sufficiently inclined to allow the material to flow along on them. Each screen is divided into two parts with different sized meshes. The first half of the upper screen allows the coarse and fine sand to drop through to the lower screen, and the second half permits the fine gravel to pass, the coarse gravel being discharged at the end of the screen into a chute leading to one of the four storage bins. The first half of the lower screen passes the fine sand, and the second half the coarse sand, into separate bins, the fine gravel being discharged at the end into another bin.

Steam power is furnished by an 80-hp. horizontal boiler. The hoisting engine is a double-cylinder 8x10-in. Flory hoist. The scraper bucket has a capacity of ½ cu.yd. The plant has been operated so as to yield 150 cu.yd. of the required material per day of 8 hr. The outfit complete cost approximately $6500 and is operated for about $20 a day, including an allowance for interest and depreciation. The plant described was designed and erected by the Cable Excavator Co., of Philadelphia, Penn., for the Waterbury (Conn.) Sand & Gravel Co., to the President of which, E. C. Whitney, we are indebted for the data here given.

Improving the Engineer's Status—A recent advertisement for a structural draftsman in a city engineer's office requires him to be competent to design bridges. This is in line with the practice of hiring rodmen and working them as instrumentmen.

Automatic Device for Rating Current Meters

BY GEORGE L. STROEBE*

An automatic device for rating current meters has been used with success for the past two years by the Bureau of Public Works, Philippine Islands. The unique feature of this device is that upon a piece of smoked paper there are automatically recorded simultaneously: (1) Meters of run of the rating car; (2) seconds of time, and (3) revolutions of the current meter.

A view of a portion of the mechanism is shown in the illustration, Fig. 1. Of the car proper only the platform is shown in the cut. The car operates on two rails laid upon opposite sides of the rating tank. The current meter is suspended from the center of the car into the tank below.

As the car is propelled forward the sprocket wheel *a* is driven by a chain which runs over a like sprocket wheel attached to the axle of the car. Sprocket wheels of motorcycles were employed, which is the reason that, in the illustration, the sprocket wheel seems unnecessarily large. The shaft to which the sprocket wheel is attached drives a worm gear as shown. This worm gear

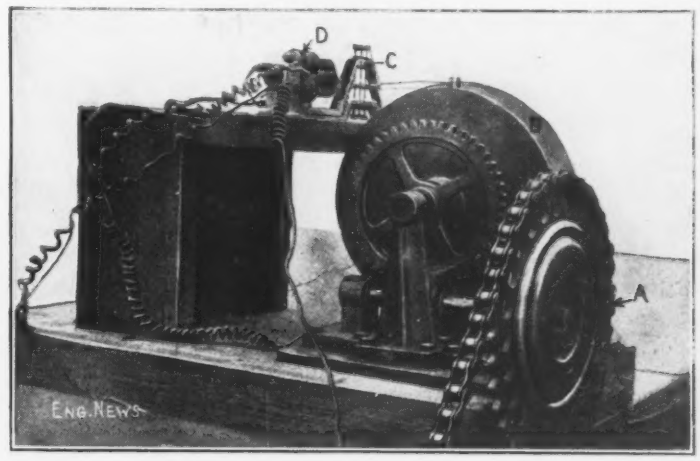


FIG. 1. AUTOMATIC DEVICE FOR RATING CURRENT METERS; BUREAU OF PUBLIC WORKS, PHILIPPINE ISLANDS

rotates the large drum *b* and the proportions of all parts are so adjusted that the drum *b* makes slightly less than one rotation while the car traverses the length of the tank, 50 m.

Upon the drum *b* is attached a piece of smoked paper, much in the same fashion that a paper record is attached to steam-engine indicators. As the drum rotates, three lines are drawn upon the smoked paper by the three pointers *c*, Fig. 1. These three pointers are capable of a slight sidewise motion which is induced by the three electromagnets *d*.

One of the three pointers *c* records upon the smoked paper meters of run of the car. To effect this, a copper wire is laid lengthwise of the track near one rail; this wire is placed on the underside of a board for 96 cm. and upon the upper side for 4 cm. A copper brush, attached to the car, runs along the board, and on contact of brush with wire the circuit is closed, and a projection is made upon the meters' line on the smoked paper record.

*Designing Engineer, Bureau of Public Works, Manila, P. I.

Another of the three pointers c records seconds of time. A clock with a second's pendulum is kept in the house in which the car is stored, and two trolley wires (not shown in the illustration) connect the car with the clock. An electric circuit is closed every second by the passage of the lower end of the pendulum through a dish of mercury, which records a projection upon the seconds' line on the smoked paper chart. The third pointer c is controlled by an electric circuit connected with the moving parts of the current meter in the usual way.

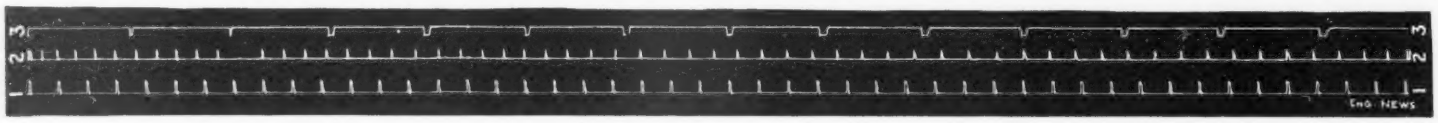


FIG. 2. SMOKED PAPER RECORD OF CURRENT-METER RATING; (1) METER OF RUN OF CAR. (2) SECONDS OF TIME. (3) REVOLUTIONS OF CURRENT METER

After the record of the test is made upon the piece of smoked paper, the paper is removed and shellacked to prevent injury to the markings. The smoking of the paper is done with a common kerosene lamp. To facilitate putting on and taking off the smoked paper from the drum b, this drum is made loose upon its shaft, but can easily be made tight by means of a screw which causes the drum to bear upon a shoulder machined upon the shaft.

A sample record is shown in Fig. 2. No matter what the speed, the projections on the meter line are uniformly spaced, giving a distance scale.

Native workmen are employed to push the car, although it could be easily made to be operated by an electric motor.

Credit for invention of this apparatus is due to Clarence G. Wrentmore, Engineer of the Philippine Department of Public Works.

❋

Length of Crossover between Curved Parallel Tracks

BY R. W. STEWART*

While the geometry of railroad alignment has been almost exhaustively covered, the writer cannot find that the archives relating to this subject contain a satisfactory treatment of the crossover between parallel curved tracks.

There is a method published in various fieldbooks for laying out such a crossover with the frogs so located as to produce a reverse curve between them. This violates the principle that the alignment through any track construction should have as little total curvature and as small a degree of curvature as possible. Also the alignment of a crossover built in this manner has a kinky appearance which causes the track foreman who builds it to think that the engineer who laid it out made a mistake.

As a substitute for this the writer wishes to submit a method of computing the length between frogs of a crossover between parallel curved tracks which will give the minimum total curvature and the minimum degree of curvature between the frogs, this condition occurring when the curve in the crossover between the frogs is a simple circular arc extending from frog to frog.

In the annexed figure let O be the common center of the parallel tracks and let A and B be the points at which the center line of the crossover is intersected by the radii of the main track curves which pass through the frog points. The problem is then to so place the frogs that the curve in the crossover between A and B will be a simple circular arc, or, in other words, the tangents to the crossover curve at points A and B must intersect at point V equally distant from A and B.

In triangle OAB the difference in length between sides OA and OB may readily be computed, being the track spacing p, minus the track gage, minus the track gage divided by the cosine of the frog angle. Call this distance m and call the radius of the arc midway between the centers of the parallel tracks R.

Then

$$OA = R - \frac{m}{2}$$

and

$$OB = R + \frac{m}{2}$$

Let Q be the center of the crossover curve and $\measuredangle$ its intersection angle. Draw radii QA and QB and we have the following relations between angles:

$$VBA = VAB = \tfrac{1}{2} \measuredangle$$

and

$$OAQ = OBQ = \text{frog angle} = F$$

In triangle OAB we have

$$ABO = 90^\circ - F - \tfrac{1}{2} \measuredangle$$
$$OAB = 90^\circ + F - \tfrac{1}{2} \measuredangle$$

By applying the rule that the tangent of half the sum

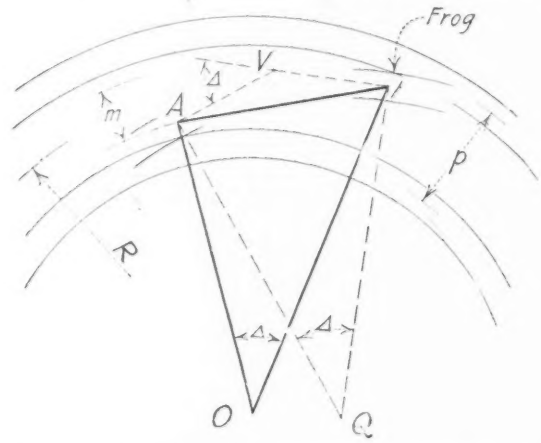


DIAGRAM FOR LENGTH OF CROSSOVER BETWEEN CURVED PARALLEL TRACKS

of two angles is to the tangent of half their difference as the sum of the opposite sides is to the differences between the opposite sides we get

$$\frac{\cot \frac{\measuredangle}{2}}{\tan F} = \frac{2R}{m}$$

*Engineer of Bridge Work, City Engineer's Office, Los Angeles, Calif.

from which

$$\tan \frac{\Delta}{2} = \frac{m}{2\,R \tan F}$$

From this last equation the value of Δ and the arc length between frogs measured along either of the parallel tracks may be computed.

Although the above equation is very easy to handle it may be transformed in such a way as to make the computation of the arc length between frogs still more convenient as follows:

By Maclaurin's Theorem

$$\tan^{-1} u = u - \frac{u^3}{3} + \frac{u^5}{5} - \frac{u^7}{7} + \ldots etc.$$

or,

$$\tfrac{1}{2}\,\Delta = \frac{m}{2\,R \tan F} - \frac{m^3}{24\,R^3 \tan^3 F} + \frac{m^5}{160\,R^5 \tan^5 F} \ldots etc.$$

from which we get

$$R\,\Delta = \frac{m}{\tan F}\left(1 - \frac{m^2}{12\,R^2 \tan^2 F} + \frac{m^4}{80\,R^4 \tan^4 F} \ldots etc.\right)$$

The series in the parentheses converges so rapidly that only the first two terms need be considered, and m is usually so small with reference to R that the second term can be neglected without appreciable error.

Note that the first term gives the distance between frogs (measured parallel to the main tracks) for *straight tracks*.

We may, therefore, say that for usual conditions the length between frogs of a crossover connecting parallel curved tracks, projected upon the arc midway between the parallel tracks, is substantially equal to the similarly projected length for straight tracks. If the radius of the curved tracks is short and an exact result is desired a correction to be subtracted from the straight track length may be computed from the second term of the above series. This need be computed only to one or two significant figures.

It may be noted that the tangent distances AV and BV of the crossover curve do not enter into this computation and therefore the length sought is in no way affected by the fact that the crossover curve ends at the heels of the frogs instead of at the frog points.

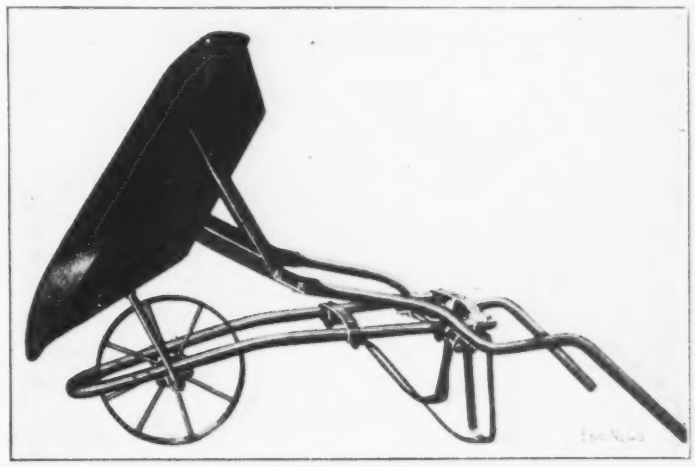
Credit for the expression of the crossover length in the form of an infinite series is due Mr. G. A. L'hommede of this office.

NOTES

The Hand Derrick Car used in the removal of a French railway bridge, as described in our issue of Apr. 24 (p. 846), was not of the mast and boom type as erroneously sketched by the draftsman. An inclined frame or boom, composed of two side timbers with lateral bracing, extended forward from about the middle of the floor of the car with sufficient overhang to carry the girder panels. This was supported near the middle by struts inclined in the same direction and seated near the front end of the floor. The hand hoist was mounted near the rear end of the boom frame, and at the rear end of the floor was a counterweight box. There was no swinging motion, as the car was simply pushed back to the adjacent yard to deposit each panel as removed, probably depositing it within reach of an ordinary crane. As the bridge acted as a temporary cantilever during its demolition, only a very light derrick car could be operated upon it.

Economy of Municipal Motor Vehicles—According to a report prepared by the General Purposes Committee of the Birmingham, England, City Council, the number of motor-cars used in the service of corporation departments is 28. They are of various types, seating from two to ten persons each, and their total cost, with accessories, was $58,500, an average of $2080 each. The annual depreciation is estimated at $296 per car and the approximate working cost per annum (including wages, uniform, etc.) at $24,000, an average of $860 per car, making with the depreciation a total of $32,400 per annum, an average of $1150 per car. The approximate car mileage run per annum is 264,150, an average of 9434 miles per car; and the cost per car mile is 12c. Seven men, six horses, and nine vehicles have been displaced, with an annual saving of $7600. The committee are unable to make any exact estimate of the saving effected by the use of the cars, but they are satisfied that the economics are very considerable, and that it would be impossible to carry on the work of the enlarged city from a single center without such provision. The city electrical engineer estimates that without the cars he would require additional inspecting officials, whose salaries would amount to over $10,000 per annum, while the city surveyor also considers that some thousands of dollars per annum in extra men and district offices have been saved by their use. [Engineering Supplement of the London "Times."]

Forward-Dumping Wheelbarrow—The Long self-dumping wheelbarrow is illustrated herewith in its dumping position. It is made and recommended primarily for concrete work, as in placing concrete for floor slabs, etc., where it is of great advantage to be able to dump the load forward over the wheel, that is, off the front of the runway on which the barrow rests. The barrow was patented less than a year ago, but is already in somewhat extensive use. However, it is a new tool, and should have just as much of a field in general

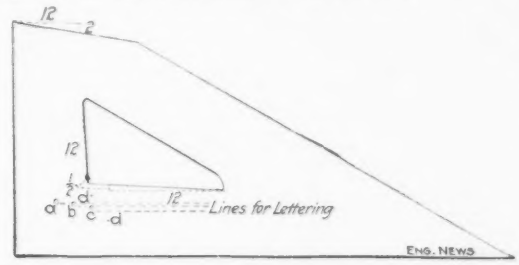


THE LONG FORWARD-DUMPING BARROW, IN DUMPING POSITION

work as in reinforced-concrete work, especially with the addition of locking lugs for throwing the self-dumping motion out of action when not wanted.

The tray of the barrow is made of No. 14 sheet steel pressed to shape, with wired edge. The main frame and handles are of steel tubing. The barrow weighs slightly more than the ordinary wheelbarrow; at the handles the difference amounts to 14 lb. lift, according to the makers. The capacity is about 3 cu.ft. level full. The barrow is made by Miller & Coulson, Pittsburgh, Penn., and is sold at $7 to $7.50.

Improving the Triangle—The adjoining sketch shows two ways to make the triangle a more convenient tool in the drafting room. The opening of the triangle and the obtuse corner are cut to frequently used bevels, as 2 in. per ft. for the flanges of structural shapes, ½ in. per ft. for masonry batters, etc. The bevels are laid out on paper, and the celluloid of the triangle is first cut away with a knife and then trimmed to the ruled line with a file.



A TRIANGLE WITH BEVELS AND WITH HOLES FOR GUIDE LINES FOR LETTERING

The holes a, b, c, etc., are for ruling guide-lines for lettering. They are cut large enough for the point of a big lead-pencil and are brought to a point in one corner. The lines are drawn by pressing the point of the pencil down in that corner and moving the triangle across the paper, along the edge of another triangle or the T-square. This device has been found very convenient. It has the advantage of drawing the lines always the same distance apart, which helps to improve the lettering. When a series of more than three lines is required, marks "d" scratched on the triangle show how far up or down to move the T-square.—Walter H. Dunlap, Roanoke, Va.

Tank Cars for Testing Bridges are used on the Swedish State Railways, thus enabling the load to be varied to suit different bridges. The tank is 10 ft. diameter and 24 ft. 3 in. long, carried on a steel frame composed of two plate sills and seven transoms. This is mounted on four axles spaced 4 ft. 3 in. apart, with 38½-in. wheels. Each axle has semielliptic springs over the axle boxes, each spring being attached to links on the sills, and no equalizers being used. The total wheelbase is 12 ft. 9 in., and the total length over spring buffers is 25 ft. 9 in. The capacity of the tank is 54 tons, and there is a graduated scale to show the weight of water at any level. The weight of the car with tank empty is 29 tons, so that the maximum loaded weight is 83 tons, or 20 tons per axle, and 3.1 tons per ft. of total length. The water for the tank is handled by a pump and benzine engine, mounted on the car.

Mensuring the Gage of Track at frogs and adjusting the frog guard-rails in proper position relative to the gage is often done incorrectly by the section foremen, through the practice of giving a uniform width of flangeway between the track rail and guard-rail. As a matter of fact, the guard-rail position should be gaged from the frog and the track rails should be set to the same gage as the adjacent portion of the track. Thus, on curves the gage through the switch and frog will be slightly wider than standard, and the width of flangeway will be correspondingly wider if the rails are laid properly. This matter was discussed in connection with the report of the Track Committee at the recent annual meeting of the American Railway Engineering Association, and rules were adopted as follows:

1. Guard-rails must be so placed that the gage distance from the frog point to the flangeway side of the guard-rail shall be at the least 4 ft. 6¾ in., and the distance between the flangeway sides of the wing rail and guard-rail shall not exceed 4 ft. 5 in.

2. The installation of frogs upon the inside of curves is to be avoided where practicable. Where this is unavoidable, the gage of track at the frog should be standard.

Roller Case for Large Map—A large road-map of Ohio that is constantly in use for reference in the office of the State Highway Department (James H. Marker, Commr., Hartman Bldg., Columbus, Ohio) is preserved and made conveniently available by mounting in a glass-covered roller case. The map is about 7 ft. wide and therefore is hard to handle and easy to injure, if used in the ordinary way. The case is like a double-topped table, with the upper layer glass. Between the glass and the main top are mounted two horizontal rollers or shafts, on which the map is rolled. The shafts extend through one end wall of the case, and have knobs here by which they can be turned, thereby rolling the map on one roller or on the other. Every part of the map is made available instantaneously, and yet the map is never touched or rubbed, folded or crumpled. The case was designed in the office of the Highway Department, and is considered a very satisfactory device.

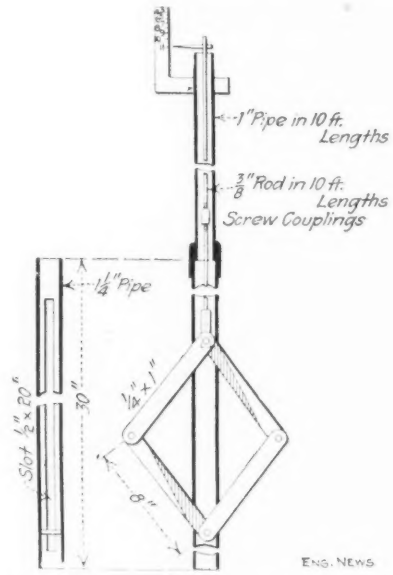
Women and Girl Road Laborers in the Philippine Islands—Women and girls are employed on road construction and even on bridge work as laborers in Cebu Province. In the construction of the Paoay-Currimao Road it is recalled that at one time there were approximately 500 women and girls employed daily. These feminine workers, receiving from 20 to 25 or 35 centavos per day, according to their strength and ability, are most efficient when materials for subgrade, surfacing or gravel and sand for concrete are to be carried a short distance. They tie up their skirts or "pandling" to be less hampered a sthey work and wield shovels, load, carry and empty their baskets with a zeal that outclasses the men.

In the construction of subgrade, Paoay-Currimao Road, it was necessary to haul material about one-half a kilometer at one point. This was accomplished with women workers. Men loaded the baskets at the borrow-pits. Baskets hold about 1/60 cu.m. and are carried on the head. On a short haul a woman will carry from a meter to a meter and a half of material per day.

As may be imagined there is considerable talking done as the work progresses, especially in the afternoon, when the women begin to tire. Ignorance of the dialect may have caused the listener to misinterpret, but it is said that the capataces (men) use some very forcible arguments to convince the ladies that they should talk less and work more.

On concrete work women are used to advantage carrying sand, gravel and water. They are not strong enough to mix concrete for any length of time, so men are employed for that purpose. The "material" gang, having filled the barrels for the next batch, are used to pass the mixed concrete to the forms, in buckets. Later, the forms having been stripped and the concrete rubbed down, a couple of women suffice to carry water and keep the green concrete wet down. ["Quarterly Bulletin" of the Bureau of Public Works, Philippine Islands, Jan. 1, 1913.]

A Caliper for Drill Holes in Rock—In the work of drilling grouting-holes in the foundation in the cutoff trench of the U. S. Reclamation Service dam at Lahontan, Nev. (see "Engineering News," Apr. 3, 1913, p. 647), there was some speculation as to how much caving of the walls of the holes occurred, and what average diameter of hole resulted after the caving and raveling of the sides of the holes. To answer these questions a caliper was made, as shown by the drawing herewith. It was designed by H. S. Rands, Asst. Engr.,



CALIPER FOR DRILLHOLES IN ROCK, USED AT LAHONTAN DAM

and was made in the works shop at Lahontan. The caliper was lowered on 10-ft. lengths of pipe and rod. The rod inside the pipe enabled the folding blades to be moved in or out, the movement being read on the scale at the top. The largest spread of the blades is 12 in. diameter. Thus the holes could be gaged at any or all points, to a size about 5 times normal diameter.

Stresses in a Model Roof-truss.—An interesting large-scale experiment was made recently in the laboratories of the University of Manchester (England). It is reported by C. H. Lander, G. Cook, and J. E. Petavel in a paper recently read before the Institution of Civil Engineers. Since ordinary roof trusses have riveted joints, while stresses are calculated on the basis of frictionless joints, it was decided to measure the stresses in a truss, as a check on the theory. A truss was designed and built for the experiment, exactly like trusses in current use. A truss of 60-ft. span being about the smallest in which the members are proportioned strictly for their stresses (i.e., without excess for stiffness, etc.), this span was adopted. But as this was too large for the facilities available, a model was made on half scale, or 30-ft. span. This was large enough to permit using ordinary rolled shapes and ordinary methods of connection, and therefore did not introduce any "model" condition, or a quality of metal not used in regular practice.

The truss was of the ordinary triangular outline with bracing arranged after the Fink or French type. The roof pitch was 30°. The design was made on the following basis: Span, 60 ft.; spacing of trusses, 15 ft.; windload, 26 lb. per sq.ft. normal to the roof; dead-load, 17¼ lb. per sq.ft. of roof surface, excluding trusses; weight of 60-ft. truss, 3000 lb. (for stress calculation only). The tension members of the truss were made of flat bars, the compression members of pairs of angles for the top chord and single angles for the struts of the web; e.g. the top chord or rafter was made of

two angles 2x2x¼ in. (representing 4x4x½-in. angles in the 60-ft. truss), while the central panel of the bottom chord or tiebeam was a ⅝x$\frac{3}{16}$ flat bar (representing 14x⅜ in.) The joints were made with ⅜-in. bolts, corresponding to ¾-in. rivets in the full-size original. The metal of which the model truss was made was subjected to tensile tests, giving an ultimate strength of 60,000 lb. per sq. in. and a yield-point of 47,000 lb. per sq.in., with elongation 25.8% in 8 in., and reduction of area 51.8%.

To test the truss, loads were applied by cords attached to individual weighted levers, one cord going to each panel-point. The truss was loaded uniformly at all panel-points in the vertical direction, and normal to the roof on one side to represent wind acting from one side. Stress measurements were made in most of the members. A micrometer gage 3 ft. long between gage-points, stated to be capable of reading to 0.0001-in., was used, with frequent check measurements on a standard bar kept alongside the truss under test. The first extensometer readings were taken at a load corresponding to one-fifth of the calculated ultimate load, and it was assumed that the deformations and stresses in the first one-fifth of total load above this first measurement would have been realized below that measurement, by which means the zero point of measurement was located.

The truss failed at a load slightly above the calculated ultimate load, by the rupture of a tension web member at a stress of nearly 55,000 lb. per sq.in. on the section through the bolt holes. This broken bar was then replaced by a slightly stronger one and the test repeated. At about the same load as the previous load the truss "suddenly failed and the free end jumped off the support. No bar was broken, the failure probably being caused by temporary buckling of the main rafter."

An important showing of the test was that the plotted curves of stress against load for the different members were in nearly all cases straight lines agreeing closely with the lines derived from calculation. For one or two members, however, the observed curves bent upward sharply near the outer end, i.e., for loads near the ultimate the elongation in such a member increased rapidly, out of all proportion to the load-increase. This occurred in the central part of the bottom chord, and in the upper section of the main tie-diagonal on the windward side. On the other hand some members showed opposite behavior, the elongation curve flattening out near the ultimate load; and the lower sub-tie on the leeward side had no tension throughout the test. These irregularities are not explained, and must be attributed to initial distortions and stresses, and to rigidity of joints. The general result that the stress curves agree closely with those calculated, and that the elongations are linear with the load even up to failure load, is not seriously affected by these minor phenomena.

Getting Good Specifications—"Citizens of New Carlisle, Ind., have just voted unanimously for the construction of 12 miles of concrete highway. The Blank Portland Cement Co. is to write the specifications, and the roadway will be 9 ft. wide with 3-ft. gravel shoulders." [Information received from Blank Portland Cement Co.]

the contractors to the builder of the trucks, the International Motor Co., reporting favorably on the work of the truck.

Congratulations in Bradford—'About the usual number of leaks in water mains occurred this year; some twenty of them, the most of them was on account of the lead coming out of the joints of cast-iron pipe; there were two joints of six-inch pipe that broke square in to, these joints were broken on account of the frost penetrating to the mains making an unequal pressure on them, we repaired these by using a Dresser split sleeve. The frost penetrated deeper last winter than it ever did in any previous winter in the history of the Bradford Water Works; there were some thirty consumers' service lines frozen up; they were thawed out by the Bradford Electric Light & Power Co.; they have a machine for that purpose which does the work very quick and easy. We were compelled to use extra precaution with a number of our hydrants or they would have frozen up, we of course can congratulate ourselves upon the theory that winters like last winter only come about once in every fifty years." [From the Annual Report of the Water Commissioners of Bradford, 1912.]

Rapid Method of Coloring Drawings—Every draftsman has has occasion at one time or another to color a drawing or a whiteprint. The use of colored inks is unsatisfactory; cross-hatching in colors obscures the details and is slow, while water colors have the disadvantage of slowness besides being difficult to apply evenly. A quick and satisfactory method of coloring involves the use of ordinary wax crayons and gasoline. Crayon of the color desired is applied and then rubbed with a piece of cloth, wet with gasoline, until the color is even, and extended to the limits desired. If it overruns the lines, it can be erased with a pencil eraser. Some colors, particularly the yellows, purples, greens and light blues, produce much better results than others. It is probable that the gasoline dissolves the wax from the crayon, leaving the pigment as an impalpable powder, which, when rubbed over the paper, colors it uniformly. The method is applicable with equal success to egg-shell and smooth drawing papers and to whiteprints on both paper and cloth. [H. P. Bowen, in the "Engineering and Mining Journal," for Feb. 8, 1913].

How They Do It in England—In our contemporary "Engineering," of May 2, 1913, we find the following record of a bit of "scientific management." It appears to have been written in a serious frame of mind:

According to the "Times," the attention of the employees at the Portsmouth Dockyard, who have declined to work overtime, has been called to the requirements of the Superannuation Acts, under which certain certificates as to conduct, qualifications, and length of service have to be produced by the head of each man's department when the Treasury is considering the award of pensions or bonuses. As far as can be ascertained, however, no attempt has been made to coerce the men by any threats that any pension or bonus may be withheld.

Paints for Tank Interiors—The experience of the Metropolitan Water-works; of Boston, Mass., indicates that red-lead paint applied to the interior of standpipes is one of the best, if not the best, protection against rusting. The paint now used is mixed in the proportion of 3 gal. of boiled linseed oil to 100 lb. of the best quality of red lead, to which is

HAULING A 70-TON STEAM SHOVEL 24 MILES OVERLAND IN MONTANA

Heavy Hauling with a Motor Truck—A 70-ton steam shovel was hauled over rough country roads a distance of about 24 miles last winter by the contractors for work on the Soo line in Montana, Siems-Carey Co. & E. A. Wickham Co. The temperature averaged 10° below zero. As the adjoining photograph shows the load was triple-headed, at least in parts of the haul. The leading engine is a 5-ton Saurer truck. The photograph accompanied a letter from

added 2½ lb. of litharge thoroughly beaten up with the linseed oil. This is the formula used by the United States Navy for paint used on the bottoms of ships. The litharge causes the paint to dry quickly and also hardens it.

The standpipe on Forbes Hill, in Quincy, 30 ft. in diameter and 64 ft. 3 in. high, was painted in 1902, at a cost of $427. The interior was first thoroughly cleaned of rust and loose paint by the use of putty knives and wire brushes. One coat

of red lead mixed with raw linseed oil and a little turpentine was then applied, and over this were applied two coats of Gilsonite paint, made by the Commercial Asphalt Co., of New York. The exterior was given two coats of white lead and linseed oil, tinted a light gray color. This standpipe is inclosed in a granite masonry tower and covered so that ice does not form to such an extent as it would if the standpipe were exposed directly to the weather. The interior of the standpipe has recently been given three coats of red lead, United States Government specification, with no covering of Gilsonite, and the exterior one coat of white lead and oil, at a total cost of $430.

At Arlington, there is a standpipe 40 ft. in diameter and 60 ft. high, with a conical steel roof and exterior spiral stairway, all exposed to the weather. The water pumped into both this and the Forbes Hill standpipe has a temperature of from 38° to 40° during the winter, and ice forms in this standpipe to a greater extent than in standpipes supplied with water drawn from ground water supplies, which does not ordinarily fall below 50°. This standpipe was painted in 1906 at a cost of $425. The interior, after being thoroughly cleaned, was given one coat of red lead and two coats of Gilsonite. The roof trusses and under side of the roof were given two coats of red lead and oil, and the exterior of the standpipe and roof one coat of white lead and oil. In 1911, this standpipe was emptied and both exterior and interior repainted in the same manner as in 1906, at a cost of $475. [Dexter Brackett, Chief Engineer, Metropolitan Water-works, in discussion at New England Water-works Association meeting; printed in "Journal" of the society for December, 1912].

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Acres Irrigated or Drained by Centrifugal Pumps

The accompanying tables show acres irrigated or drained in stated intervals of time based on the theoretical capacities of centrifugal pumps. Factors which assist or hinder the work of pumping, such as percolation, evaporation, seepage, runoff and waste, are not allowed for in the tables, for these depend almost entirely upon local conditions. When these are determined the pumping capacity should be decreased or increased proportionately and the acreages shown must be multiplied by the proper factor. The tables were prepared by R. C. Wise, Secretary of the Western Pump & Engineering Co., Chicago, Ill., and are copyrighted by him.

TABLES OF AREAS

Diam. of discharge (in.)	Theoretical capacity of pump in gal. per min.	Acres, Irrigated or Drained in 10 hr. Depth 1 in.	2 in.	4 in.	6 in.	8-in.	10 in.	12 in.
	25	0.55	0.28	0.14	0.09	0.07	0.05	0.05
	50	1.10	0.55	0.28	0.18	0.14	0.11	0.09
1½	70	1.55	0.77	0.39	0.26	0.19	0.15	0.13
1¾	90	1.99	0.99	0.50	0.33	0.25	0.20	0.17
2	120	2.65	1.33	0.66	0.44	0.33	0.27	0.22
2½	180	3.98	1.99	1.00	0.66	0.50	0.40	0.33
3	260	5.74	2.87	1.44	0.96	0.72	0.57	0.48
3½	330	7.29	3.65	1.82	1.21	0.91	0.73	0.61
4	470	10.39	5.19	2.60	1.73	1.30	1.04	0.87
5	735	16.24	8.12	4.06	2.71	2.03	1.62	1.35
6	1,050	23.20	11.60	5.80	3.87	2.90	2.32	1.93
7	1,500	33.14	16.57	8.29	5.52	4.14	3.31	2.76
8	2,000	44.27	22.10	11.05	7.37	5.52	4.42	3.68
10	3,000	66.29	33.14	16.67	11.04	8.29	6.63	5.52
12	4,200	92.80	46.40	23.20	15.47	11.60	9.28	7.74
15	7,000	154.62	77.34	38.66	25.78	19.33	15.47	12.89
18	10,000	220.96	110.48	55.24	36.83	27.62	22.10	18.41
20	12,000	265.15	132.57	66.29	44.19	33.15	26.52	22.10
24	15,000	331.44	165.72	82.86	55.24	41.43	33.14	27.62
30	22,000	486.12	243.06	121.53	81.02	60.76	48.61	40.51
36	32,000	707.08	353.54	176.77	117.85	88.39	70.71	58.92
42	44,000	972.23	486.12	243.06	162.04	121.53	97.22	81.02
48	60,000	1325.77	662.89	331.44	220.96	165.72	132.58	110.48
60	75,000	1657.21	828.61	414.30	276.20	207.15	165.72	138.10
60	100,000	2209.63	1104.81	552.40	368.27	276.20	220.96	184.13

Diam. of discharge (in.)	Theoretical capacity of pump in gal. per min.	Acres, Irrigated or drained in 24 hr. Depth ¼ in.	½ in.	1 in.	2 in.	4 in.	6 in.
	25	5.30	2.65	1.33	0.66	0.33	0.22
	50	10.61	5.30	2.65	1.33	0.66	0.44
1½	70	14.85	7.42	3.71	1.86	0.93	0.62
1¾	90	19.09	9.54	4.77	2.39	1.19	0.80
2	120	25.45	12.72	6.36	3.18	1.59	1.06
2½	180	38.18	19.09	9.54	4.77	2.39	1.59
3	260	55.15	27.57	13.79	6.89	3.45	2.30
3½	330	70.00	35.00	17.50	8.75	4.38	2.92
4	470	99.69	49.85	24.92	12.46	6.23	4.15
5	735	155.91	77.95	38.98	19.49	9.74	6.49
6	1,050	222.73	111.36	55.68	27.84	13.92	9.28
7	1,500	318.19	159.09	79.55	39.77	19.89	13.26
8	2,000	424.25	212.12	106.06	53.03	26.52	17.68
10	3,000	636.37	318.18	159.08	79.54	39.77	26.51
12	4,200	890.92	445.46	222.73	111.36	55.68	37.12
15	7,000	1484.86	742.43	371.22	185.61	92.80	61.87
18	10,000	2121.22	1060.61	530.30	265.15	132.58	88.38
20	12,000	2545.48	1272.74	636.37	318.19	159.09	106.06
24	15,000	3181.85	1590.92	795.46	397.73	198.87	132.58
30	22,000	4666.70	2333.35	1166.67	583.34	291.67	194.44
36	32,000	6788.0	3394.0	1697.0	848.50	424.25	282.83
42	44,000	9333.4	4666.7	2333.4	1166.7	583.34	388.89
48	60,000	12727.5	6363.7	3181.9	1590.9	795.46	530.30
60	75,000	15909.3	7954.6	3977.3	1988.7	994.32	662.89
60	100,000	21212.3	10606.1	5303.1	2651.6	1325.8	883.84

Diam. of discharge (in.)	Theoretical capacity of pump in gal. per min.	Acres, Irrigated or Drained in 30 days, pumping 24 hr. per day. Depth 6 in.	12 in.	18 in.	24 in.
	25	6.63	3.31	2.21	1.66
	50	13.26	6.63	4.42	3.31
1½	70	18.56	9.28	6.19	4.64
1¾	90	23.86	11.93	7.95	5.97
2	120	31.82	15.91	10.61	7.95
2½	180	47.73	23.86	15.91	11.93
3	260	68.94	34.47	22.98	17.23
3½	330	87.50	43.75	29.17	21.87
4	470	124.62	62.31	41.54	31.16
5	735	194.89	97.44	64.96	48.72
6	1,050	278.41	139.20	92.80	69.60
7	1,500	397.72	198.86	132.57	99.43
8	2,000	530.30	265.15	176.77	132.58
10	3,000	795.45	397.73	265.15	198.86
12	4,200	1113.63	556.82	371.21	278.41
15	7,000	1856.06	928.03	618.69	464.01
18	10,000	2651.51	1325.76	883.83	662.88
20	12,000	3181.81	1590.90	1060.60	795.45
24	15,000	3977.27	1988.63	1325.76	994.32
30	22,000	5833.32	2916.66	1944.44	1458.33
36	32,000	8484.83	4242.42	2828.28	2121.21
42	44,000	11666.6	5833.3	3888.9	2916.7
48	60,000	15909.1	7954.5	5303.0	3977.3
60	75,000	19886.3	9943.2	6628.8	4971.6
60	100,000	26515.1	13257.6	8838.4	6628.8

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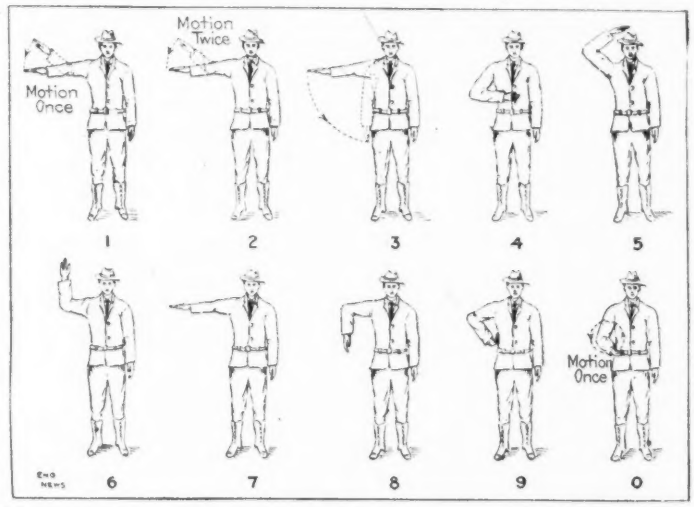
Manual Signals for Field Engineers

For survey work on the Chicago, Burlington & Quincy R.R. a special set of manual signals has been devised for signaling numbers, and these are shown on the accompanying drawing, the figures being redrawn from a blueprint furnished us by F. T. Darrow, Engineer of Maintenance-of-Way for lines west of the Missouri River. The blueprint is 3½x7 in., punched for convenient insertion in a loose-leaf note book. It will be noted that each signal or number is made with one hand, so that a man



MANUAL SIGNALS FOR FIELD ENGINEERS: C., B. & Q. R.R.

can hold his rod or other device while signaling. It is found very desirable for a rodman to carry a peg book and work with the levelman in checking turns and benchmarks. A self-reading rod is used, and figures are transferred between the men by means of these signals. Station numbers and plusses on transit work are explained in the same way.

EDITORIALS

For the sixth time since 1884, when the U. S. Geological Survey took up rented quarters in an office building in the City of Washington, a fire has seriously threatened the many valuable records it is the business of that bureau to collect. We trust that Congress will not further tempt Providence, but will immediately authorize the construction of the new building for which the last Congress provided the site. Under the usual procedure it will be many years before the Survey can move into a fireproof structure where the notes and results of its country-wide surveys will be safe. These many threatening fires and the irreparable loss of New York State records in the recent Capitol fire at Albany should rouse the federal legislators beyond their usual comfortable routine.

Co-operative Buying for Public-Service Employees

One of the notable industrial movements, aiming to break the vicious spiral of increasing cost of living and increasing wages, is the recent establishment of coöperative buying departments for the employees of public-service corporations. What seems to be one of the most successful examples of this is the procedure recently adopted by the Interborough Rapid Transit Co. of New York City and its allied concern, the New York Railways Co. These concerns operate the elevated and subway systems of Manhattan Borough in the City of New York, and a majority of the surface electric railways as well. These companies have established a system under which they buy and sell at cost, food supplies for employees and their families, maintaining at different points on company property stores through which the supplies are distributed (see ENGINEERING NEWS, Feb. 13, 1913, p. 309). This scheme is simple and, it is reported, effective.

Another plan has been put into operation by the Philadelphia Rapid Transit Co., which seems to have somewhat the same advantages for the men with less responsibility on the part of the company, but with the chance of unfairness toward some portion at least of the general buying public. The scheme at Philadelphia, according to a bulletin published by the company, involves a Coöperative Beneficial Association, so called, membership in which is open to male employees of the company at a cost of 50 cents admission fee and 25 cents per month dues. The company contributes an equal amount and pays all expenses of the association. This association, however, does not buy and sell supplies. It has, instead, closed contracts with one department store in Philadelphia and one coal company (and proposes to make other contracts) whereby special discounts are secured to members of the association—discounts which apply to "bargain" sales as well as to ordinary transactions. Coal can be purchased in tons of 2240 lb., and without the extra charge of delivery exacted for certain localities. Books of cash coupons are sold at a discount to members and these are accepted by the contracting mercantile houses in payment of purchases.

The chance of unfair discrimination between such special customers of these firms and the general purchasers, arises from the fact that there seems to be no separation of the two kinds of business and no assurance that each class pays for its own costs or contributes only its own share to the merchants' profits.

The plan does have the advantage that it secures for the employees a discount on their purchases of goods as well as food supplies. It is, however, open to the possible objection that giving rebates to one special class of customers may amount to a tax on the general buying public which has to pay the ordinary scale of prices. On the other hand, careful watching will be advisable to see that the employees receive the same quality of goods as those who purchase at the full rates.

Both these experiments in New York and Philadelphia will be observed with interest.

A Valuation of a Large Street-Railway System

We devote considerable space, elsewhere in this issue, to a report by B. J. Arnold on the value of the street-railway system of Kansas City. This is a good example of a thoroughgoing valuation by a man of large experience in work of this nature. Because of the recent legislation requiring valuation of the railways of the country, the report is of special interest at this time. It contains assembled in form for parallel comparison, three quite different principles of valuation, useful in establishing a proper basis for capitalization, and specifically applies the theories to the case in hand to test the fairness of the figure finally established. This concise presentation of theory and application is beyond the scope and treatment of the existing works on valuation and is, therefore, given nearly in full, but necessarily without the supporting data, which fill three volumes.

There are a number of matters, seen at different points in the report, which are of special independent interest. For instance, the railway companies in Kansas City, in years past, have suffered the unfortunate experience of having bridges washed away together with enforced supersession of various other property. Mr. Arnold advocates capitalizing the value of this lost and discarded property, together with a capitalization of the deficit which may have accumulated on such impaired investments. But he recommends that, in the reorganization of the company and the grant of new franchises, the amortization of such development costs, not now present in tangible plant, should be cared for.

Engineers and railway men who are worrying at this moment as to the problem of financing the enormous flood damage in the Middle West, will see that it is permissible and even desirable that this year's operating expenses should not be loaded with all of this unusual

burden, but that it should be temporarily included in capitalization and gradually repaid from net earnings.

In addition to establishing the value of the Kansas City system as a whole, the final value is distributed by Mr. Arnold among the communities served. This is done mostly in accordance with the origin of gross receipts and the actual local investments. To many interested in this work the question at once arises as to why this procedure was taken. Why should it be on such a basis rather than according to track miles or car miles for each locality, or any other unit which may be devised?

It is often illuminating in answering such questions to hark back to our elementary ideas of economics and civil government. We realize that for stability of business and the protection of property, municipal government is necessary. Where a public utility serves more than one community, a measure of its reliance on each local government, from the property standpoint, is found in the proportion to which the local investments (including a proportion of rolling stock in the case of steam and electric railways) bear to that of the whole system. Viewed from the service standpoint, the stability of local municipalities affects a concern's value in proportion to the factor that the local customers form of the entire business. Another way of expressing the same idea is by saying that the total capitalization value may be divided in proportion to the origin of gross business.

It is interesting to note that in many cases the apportionment of value is approximately the same under either scheme. The Kansas City railways present such an instance. As a general rule, however, the two ideas could be expected only to define limits within which the final value would fall.

The local assignment of capital value, moreover, is not necessarily a fair basis of taxation. Indeed, more often than not, local reduction from real to assessed values would be made on actual physical property with perhaps such treatment of intangible values as is found necessary under the conditions locally encountered.

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The Bourne Scheme for Federal Aid to Road Construction

Ex-Senator Jonathan Bourne, Jr., of Oregon, who was chairman of the Joint Congressional Committee on Federal Aid for Roads, has made public his scheme for Federal aid to road construction by the several States. Senator Bourne declares that Federal aid to roads is "the greatest and certainly the most important economic question now before the American people."

His scheme is substantially the lending of the Federal government's credit to the several States so that they may be able to borrow money for road construction at a lower rate than would otherwise be possible. According to the terms of a bill which Senator Bourne has drafted, the Federal government would issue and sell 3% bonds to the amount of $1,000,000,000, and the money realized from the sale of these bonds would be apportioned to the several States according to their land area, population, assessed valuation, and total mileage of public highways.

Each State, in order to obtain its percentage of this fund, would have to turn over to the Federal government its own bonds for an equal amount bearing interest at 4%, and would pay interest on these bonds annually to the government. These payments by the States would be made use of by the government to pay the 3% interest on its own bonds and the 1% remaining would constitute a sinking fund, which if invested at 3%, Mr. Bourne computes, would amount to sufficient to retire the bonds at the end of about 46 years.

The States would use this money for road construction in such manner as they pleased. Mr. Bourne does not propose that the Federal authorities shall interfere in any way with the States' right to build their highways as they see fit. He provides, however, that the Federal government shall also aid in the maintenance of highways, giving to each State annually, by direct appropriation from the Federal treasury, an amount equal to one-fiftieth of the amount allotted to it for road construction. Thus the Federal government would make a gift of $20,000,000 annually to aid the work of highway maintenance in the several States. There would be authority to withhold this gift, however, from any State which had not wisely handled its previous Federal fund for construction and maintenance, or had not spent at least an equal amount for maintenance of roads. This last provision, of course, means nothing, as every State is already expending in the work of highway maintenance far more than the proposed amount of Federal aid.

As a capstone to Senator Bourne's remarkable edifice, he proposes to establish in the District of Columbia a school of highway and bridge engineering. The school would have a two years' course, and every congressional district in the United States would be entitled to one student, who would be paid by the government four cents a mile for traveling expenses from his home to Washington and $50 a month during the period of his instruction.

It should be particularly noted that this scheme is simply the personal scheme of Ex-Senator Bourne, which has been offered for the use of the joint Committee, but has not been adopted by it. It will probably be held up, as a chief merit of the scheme, that it makes no draft on the Federal Treasury for road construction, although in the 50 odd years during which the bonds to be issued are to run, the Federal government would pay to the States for road maintenance, in the neighborhood of a billion dollars.

Whatever merit may attach to the scheme because the government lends only its credit to the several States, instead of making them an outright gift in cash, is more than offset, in our opinion, by the fact that the bill, if enacted, would have an enormous influence in inducing the States to undertake road construction work with money borrowed on long-time bonds.

As has been many times shown, to borrow money on long-time bonds, for building street pavements and roads, is little less than financial suicide. The present too common policy of states and cities, of relying wholly on bond issues for carrying on public works, cannot be too emphatically condemned.

When Mr. Bourne's scheme is analyzed, it will be seen that instead of the Federal government giving the States a billion dollars to spend on good roads, what it actually does is to induce the States to borrow this amount of money to build roads, which money must be repaid, principal and interest, by the State's taxpayers. In case any State should default in its payment of interest and principal, the deficiency would then fall on the taxpayers of the United States. It is a popular fallacy that by rais-

ing money on bond issues for public work, the public gets what it wants without having to pay for it. People forget that the payment must be made just the same, and not only the principal of the bonds but the interest must be met year after year until the burden of debt can be lifted. A large proportion of our American cities are today struggling under a huge burden of debt, and are constantly hampered in their desire to carry out improvements and new public works on account of the burden of debt which was loaded upon them by a past generation.

There is something to be said in defense of the issue of bonds by states and cities to construct public works which yield a revenue, from which revenue the bonds can eventually be repaid. Pavements and roads, however, yield no revenue. On the contrary, they involve a heavy annual expenditure for maintenance. Necessary and advantageous though they are, where the traffic and taxable wealth is sufficient to justify their construction, they should be built either from the proceeds of annual taxation or by the issue of bonds running for a short term of years, not greater than the life of the roads or pavements themselves.

It is evident that Senator Bourne, in common with a large proportion of the public, has been misled by the fallacious statements in good-roads literature, with the misleading statistics as to the cost of haulage over common roads and the saving which can be made by the substitution of paved roads. In the preface to his report, Senator Bourne says:

> A great system of rural transportation would be developed, with rates regulated by actual competition, open to poor and rich alike, as no expensive, privately owned terminals, roadbeds, tracks or equipment would be required.

The obvious inference from the above is that if the proposed network of good roads were built it would be possible to transport goods over them at less cost than the present cost of carrying goods by rail.

In contrast with this, we have recently had laid before us figures showing the actual cost per ton mile of carrying goods by the latest type motor truck running on good roads. These ton-mile costs were more than 20 times as great as the average ton-mile cost of freight transportation on railways. Further, these ton-mile costs of transportation by motor trucks were not more than 20 per cent. below the figures widely published by the Department of Agriculture a few years ago, as the average cost per ton-mile of hauling farm produce over ordinary dirt roads. This difference of 20 per cent. would be no more than sufficient to cover the interest and maintenance cost of the paved highways over which the motor trucks ran.

An excellent comment on the fallacies underlying Senator Bourne's schemes is contained in a letter from Mr. Walter C. Taylor, of Brookline, Mass., to the "New York Times" from which we quote as follows:

> Any road plan which wholly ignores the very existence of the real National "highways" of all modern times, namely, the railroads, is likely to be futile. There is not a word in the Senator's plan which recognizes the truth that the only modern economic use for wagon roads is local travel and the transportation of commodities to and from the nearest railroad.
>
> The chief owner of the great Pillsbury flour mills in Minneapolis once declared that he "could deliver a barrel of flour on the Liverpool docks cheaper than he could at half the homes in Minneapolis." That is, it cost him a thousand times as much to haul it over a local "highway" by wagon to the rim of Minneapolis as it cost per ton per mile loaded into a freight car and, with only one change to be made, in the trip by rail and ship to Liverpool.
>
> To the producer on the farm, as to the consumer in the city, the great question is, "How shall we get goods to and from the freight station?" And no system of road building is either scientific or of economic justification which does not view the wagon road in its proper aspect as being today (and for fifty years back) only a secondary auxiliary system, doing perhaps one-hundredth, perhaps one-thousandth, of our total of commodity transportation.

The Water Filtration Hold-Up in New York City

The hold-up of the Croton filter-plant contract by the New York Board of Estimate has no apparent engineering justification. The arguments raised against the award have centered around claims that filtration is unnecessary, that further investigations are needed and that the specifications and contract are faulty.

It is late in the day to urge that filtration is not needed. That plea should have been made, if at all, long before receiving bids for a filter plant. The fact is, that the need for filtration has been urged by a host of eminent engineers and sanitarians, in and out of the city service, for ten years or more, to say nothing of the demand for it on the part of the medical profession and the public.

As to the need for further investigation, the subject of filtration has been studied diligently by New York City's own engineers for a half-dozen years or more. Experiments on a working scale have been made with the Croton water and New York City has had the benefit of the actual experience of many of the leading cities of the United States and Canada which have installed filtration works while it has been postponing like action.

The plans and specifications on which bids were received on Jan. 23, 1913, were prepared by a special staff of 25 to 30 filtration engineers, many of whom were selected because of their previous experience in designing and building the most notable filtration plants of this country.* Since the plans were completed they have been

*In addition to Geo. W. Fuller, consulting engineer to the Filtration Division of the Department of Water-Supply, and Elmer G. Manahan, in direct office charge, both of whom have had long and varied experience in water filtration, the Filtration Division includes 32 employees, 15 of whom are of the grade of assistant engineer or higher. Of the latter the record of a half dozen are here given to show the range and variety of their experience:

T. C. Atwood, Division Engineer:
- 3 years with the Bureau of Filtration, Philadelphia, Penn., on the design and construction of the Torresdale filters.
- 3 years with the Bureau of Filtration, Pittsburgh, Penn., in charge of part of the design and construction of the Pittsburgh filters, and
- Part of the time for 2 years upon preliminary work for the proposed Eastview filters for the Board of Water Supply of the City of New York.

Charles B. Buerger, Assistant Engineer:
- 5 years with the Bureau of Filtration, Philadelphia, Penn., at first on the preliminary filters for the Torresdale and Belmont plants and later in charge of the design of the Queen Lane filter plant.

F. H. Stephenson, Assistant Engineer:
- 2 years with Allen Hazen, consulting engineer, during a part of which time he had charge of the construction of the filter plant for Yonkers, New York, and during the remainder of the time was engaged upon filter work for other cities and towns.
- 4 years with the Commissioners of Water-Works of the City of Cincinnati, Ohio, during most of this time in direct charge of the construction of the Cincinnati filter plant.
- 1½ years at Evansville, Ind., in charge of the construction of the Evansville filter plant.

A. R. Holbrook, Assistant Engineer:
- 1 year in connection with the Pittsburgh, Penn., filtration plant.

A. V. Ruggles, Assistant Engineer:
- 2 years with Allen Hazen, consulting engineer, on various filter projects.
- 1 year on preliminary work for the proposed Eastview filters, for the Board of Water Supply, New York City.

E. Nuebling, Assistant Engineer:
- During the years 1907 and 1908, employed upon the preliminary studies for the then proposed filter plant at

heartily approved by two boards of engineers and sanitarians, the members of which included a number of consulting filtration engineers, besides consulting and other engineers in the employ of the city but in no way connected with the water department. Altogether, it is safe to say that no other filtration plans bear the stamp of approval of so large a number of engineers as do these. The satisfactory character of the plans and specifications have been further attested by the number and standing of the bidders, the closeness of the bids to the original engineer's estimate, and the substantial agreement between the latter and the independent estimates made by the latest board of consulting engineers. Reference to alleged faults in the specifications will be made further on.

Perhaps the most remarkable feature of this hold-up is the claim that filtration is not needed. We shall not repeat here the convincing arguments of the many engineers who have strongly recommended filtration, since they are given at length elsewhere in this issue.* We do wish to point out that Comptroller Prendergast, who is the leading official opponent of awarding the contract, not only joined in all the preliminary steps of authorizing bonds for filtration, directing the water department to prepare plans, and giving it permission to advertise for bids, but he also took a part in summarizing and indorsing the arguments for filtration no longer ago than 1911. Joined with Comptroller Prendergast in signing the report authorizing bonds for filtration was the President of the Borough of Manhattan. The third signer, the President of the Board of Aldermen, declared for the contract award in a test vote taken not long ago, but it is reported that the opponents of filtration hope to win him over when the matter comes up for final action in the Board of Estimate on the date of this issue of ENGINEERING NEWS. To add to the mysteries of this last-minute hold-up, not only the borough president of Manhattan, as has just been stated, but also the borough president of The Bronx is also reported to be a party to the hold-up—which is all the more remarkable because the filtration of the Croton water-supply is solely for the benefit of the two boroughs named, and is favored, it is said, by the presidents of the other boroughs composing Greater New York. We bring out these points in a local controversy because of the importance of the contract at issue, both in size and in relation to the progress of water purification in America; and also to make it clear that quite other than engineering considerations underlie the hold-up.

In passing, we may note, as bearing upon the attitude of Comptroller Prendergast and the other opponents of awarding the contract, that the hold-up has been continued for some weeks since the board of engineers appointed to report on the objections raised against the contract unanimously indorsed the plans, specifications, engineer's estimate and the lowest bid for the work, and also reported 4 to 1 in favor of immediate filtration.

A surprising feature of this filtration controversy has been the part played in it by the Bureau of Municipal Research and the Citizens' Union of New York City, two closely related civic organizations. As appears elsewhere in this issue, each of these bodies has founded a large part of its criticisms of the filtration project upon misconceptions of the engineering problems involved. When a civic organization starts a crusade against a municipal department or contract it ought to be sure of its ground. There may be some excuse for uncertainty and error on the part of the ordinary civic organization, but for the pioneer Bureau of Municipal Research to make the technical errors it made last December and January and then trip itself up in correcting them was most unfortunate. Its good intentions in this matter and solid achievements in others will certainly lead its friends and well wishers to overlook these errors.

There remain, for brief notice, the allegations of the Bureau of Municipal Research and the Citizens' Union that the filter specifications and contract contain objectionable features, especially in that they provide for letting all the work in one contract, including patented devices which might better be contracted for separately, and that they are indefinite at some points and leave too much to the discretion of the engineers. Aside from the fact that these questions are ones which must be left largely to the experience and judgment of the engineers responsible for each individual contract, since there is no general agreement as to the details of the principles involved, it is sufficient to note: (1) That the consulting experts approved the specifications with these features included and that the objectors did not seem to fully grasp all the technical points involved. If the Citizens' Union obtains standing for its taxpayers' suit perhaps these points will be adjudicated, but we think we take no risk of being adjudged in contempt of court if we predict that unless the Citizens' Union has something more serious to contest than it has yet made public no court of final jurisdiction will give much weight to its contentions, which all seem to involve points wholly within the judgment and discretion of the city authorities.*

Before summing up this remarkable hold-up, attention may be called to the fact that Allen Hazen, chairman, and Geo. A. Johnson, secretary, of one of the boards of consulting engineers which approved the filtration plans, have no later than May 20 written strong letters reviewing the reasons for installing a filtration plant without delay. Extracts from their letters appear at the close of our review, elsewhere in this issue.

To sum up this controversy: The water and health authorities of New York City, its various engineering advisers, the press and the public generally, have persistently urged filtration for years; the Department of Water Supply has studied the subject for a half-dozen years, aided by eminent specialists; the Board of Estimate itself has authorized plans and specifications and the advertising for bids for a filter plant; plans have been

Jerome Park, and also upon the design and construction of the Oakland Lake filters, constructed at Bayside, Long Island, by the Department of Water Supply, New York City.

*First of all, to go back only ten years, Prof. Wm. H. Burr, Rudolph Hering and John R. Freeman (Providence, R. I.) advocated filtration. These were followed by J. Waldo Smith, Allen Hazen, Geo. C. Whipple. The first board of consulting engineers on the present plans included Mr. Hazen, Geo. A. Johnson, Frank A. Barbour (Boston), Prof. W. P. Mason (Troy, N. Y.), and James H. Fuertes. The second board of engineers included Nicholas S. Hill, Jr., and John H. Gregory, engineers in private practice, and E. P. Goodrich, consulting engineer to Borough President of Manhattan, Amos L. Schaeffer, consulting engineer to the Borough President of The Bronx, and John H. Frazee, assistant engineer, Department of Finance, New York City. All these except Mr. Frazee have agreed on the need for filtration; the last ten, including Mr. Frazee, have approved the filtration plans.

*In fairness, it should be mentioned here, as is brought out more specifically in our review of this case elsewhere in this issue, that the Citizens' Union cites Major Cassius M. Gillette, of Philadelphia, in support of some of its allegations as to faults in the specifications, and states further that he and other experts (no other names given) concur in its claims that filtration is unnecessary at present.

made by a notable force of filtration experts and approved by numerous eminent and competent consulting engineers; bids have been solicited, competition secured and a low bid received. At this happy consummation, the Board of Estimate, which has been party to the preliminary steps, is urged by some of its members to rescind its earlier favorable action, kill the project and deprive two or three million people of the disease-germ-free, clear, colorless, tasteless and odorless water to which they are justly entitled. To go back on its own action at this late day, to serve notice on the engineering and contracting world that New York makes plans and secures bids for great public works and then concludes that those works are quite unnecessary, to nullify a ten-year campaign for filtration and deny the citizens of Manhattan and the Bronx of a water-supply equal to that of the other leading citizens of the United States, needs other justification from the opposing members of the Board of Estimate than has yet been given or than we believe can be found.

LETTERS TO THE EDITOR

Effect of Sugar on Concrete

Sir—I have read with interest the recent letters from your correspondents, dealing with the action of sugar on cement. An instance of similar disintegratory action has recently come under my notice.

About four years ago, my company constructed a reinforced-concrete floor in a wholesale grocery establishment, in this city. The floor was finished with 1:2 mortar ¾ in. thick surface hardened with a wash of silicate of soda. This finish has disintegrated just by a raisin-seeding machine, where the floor is always to a certain extent moist with raisin syrup; and although the floor plate itself is still sound, the destruction of the surface finish indicates apparently that a destroying agent is slowly at work.

H. GORDON JENKINSON.
Resident Engineer, South Australian Reinforced Concrete Co., Ltd.
Adelaide, So. Australia, Mar. 14, 1913.

The Engineer's Need

Sir—In the current issue of ENGINEERING NEWS (p. 863), Prof. C. T. Morris calls attention to the fact that all rules for wind-stresses in structures are open to the criticism that they are based on assumptions not in accord with the facts, and further that it is Mr. C. Melick's opinion that analytical determination of stress is far too cumbersome for practical use and, therefore, some sort of empiricism is necessary.

Not only are both ideas true in this case—and in many other cases likewise—but also it is to be wished that both could be so indelibly engraved on every engineer's mind that neither could be lost sight of for an instant.

Scientific knowledge requires to be correlated for the practical activities of the engineer, and may be said to consist of two main parts. In popular language we may call these two divisions Research and Practice. Practice demands a codification of physical facts and laws, and a faith in their exactness and sufficiency. Research demands a less assurance, and an almost vacillating mind, alert and ready to accredit each newly found physical fact, a humble meekness leading to the laying aside of the code of the engineer, and an ever-readiness to view all sides of a subject and by properly weighing evidence to form a tentative judgment as to the correct procedure under the then existing state of knowledge.

At times we see these two sets of faculties both operating at one time in one person, but this is an unusual spectacle. More ordinarily we see the codifiers and the practitioners sharply separated, with almost an enmity between them. Witness for example, the estimation accorded a college professor in a steel mill. This is a condition that is sad, because these gentlemen often do the codifying from highly altruistic motives, although it must be confessed that they are at times driven to the effort by the need to piece out an entirely inadequate income. A little human kindness should be extended to them for unavoidable lack of practical knowledge, remembering that practical men often hand out to them not a little "bushwa" and that it is small wonder if one of our learned friends is misled at times to such an extent as to put into his book (or code) something that a fuller knowledge may show had been better omitted.

Business is a curious growth often based on ability to disseminate partial truths. We see it using the product of the codifiers' labor but exalting the formula above the physical facts which the formula (at best, only partially) expresses. Many of these formulas are based on an idea of perfection and thus are of practical utility only when modified into empirical rules that are of limited applicability.

Lord Kelvin has called especial attention to the need to hold the facts in mind, saying "Nothing can be more fatal to progress than a too confident reliance on mathematical symbols; for the student is only too apt to take the easier course, and consider the formula and not the fact as the physical reality."

JOHN AUSTEN.
McKeesport, Penn., Apr. 26, 1913.

Another Scheme to Rob Mississippi Floods of Their Terrors

Sir—Apropos of the discussion among "Civil Engineers" and others of methods for controlling the floods in the Mississippi River, the following solution, advanced by a brother in the electrical field, certainly deserves the same serious consideration afforded in the newspapers to the reforestation method, the reservoir method (both movable and immovable) and the more

recent plan for a channel ten miles wide from Cairo to the Gulf on the west side of the river.

Briefly, the plan is this. Confine the river in a concrete flume, say ten miles long and five wide. Cover the floor of this flume with a network of iron wires. Run transmission lines to all power plants within 1000 miles. Then, when a flood comes, let the government take control of these power plants for as long as necessary, and concentrate their entire output on heating these wires. In this way, the flood waters would soon be evaporated, and this vast volume of vapor could be directed by blowers, also run by electricity, against the Rocky Mountains, where it would be precipitated and rendered available for the irrigation of the entire arid West!

H. E. PHELPS, City Engineer.

Boulder, Colo., May 12, 1913.

Flange Width in T-Beams in Tile and Concrete Floors

Sir—In the many reports and regulations for reinforced-concrete design the subject of T-beams is dealt with in as many different ways. The National Association of Cement Users permits the width of flange, measured from the edge of the stem, to equal six times the flange thickness. The Report of the Joint Committee on Concrete and Reinforced Concrete limits the overhanging edge to four times the flange thickness. The Chicago building ordinance limits the width to be used in compression to three-fourths the distance center to center of ribs.

Apply these regulations to a combination tile and concrete floor. Assume a floor having a total thickness of 7 in., consisting of a 2-in. flange and 5-in. tile, with 4-in. wide stem. The distance center to center of stems, or ribs, is 16 in. Under the first rule above given, the width of the beam assumed as a rectanguiar beam is 28 in. Under the second rule above given the width is 20 in. Under the Chicago rule the width of the beam is 12 in. The question of shear must enter and if this is limited to 40 lb. per sq.in. on the cross section of the rib, $4 \times 7 = 28$ in., the resisting moment may be considerably less than if any of the foregoing rules be followed. That is, no matter what rule is given for the maximum flange width the unit shear really governs, for it is ridiculous to attempt to put stirrups for web reinforcement in such narrow stems.

All the reports mentioned, as well as all the building ordinances the writer has seen, are defective in their neglect to state specifically the application of their rules to combination tile and concrete floors. In Chicago, for example, if the ordinance is followed the extreme flange width to be taken into consideration on such a floor would be 12 in. and the maximum shear 40 lb. per sq.in. It is the practice of the architectural engineers who examine building plans to consider the whole width, center to center of ribs, and allow a shear on the rib section as high as 75 lb. per sq.in. This is done for the reason that the web of the tile adjoining the concrete section is counted on to furnish web strength. The unit shear on the tile and concrete is 40 lb., which occasionally means 75 lb. on the concrete rib alone. In addition to this, one bar must be turned up. The stand taken by the engineers is said to be due to a number of tests made on such floors. Personally the writer does not like it but on this point evidence is sought from such of your readers as may be inclined to give an opinion.

ERNEST MCCULLOUGH.

Monadnock Block, Chicago, Ill.

Mar. 12, 1913.

A New Move for Water Filtration at Cleveland, Ohio

Sir—In view of the editorial comment on the Cleveland water situation in your issue of May 15, it will probably be of interest to you to learn that Mayor Baker has this week in effect declared himself in favor of filtration and appointed a commission to investigate the best method of treatment and the cost involved. The mayor urges that the report be submitted as early as possible.

In the meantime the State Board of Health, to whom an appeal has been made by the local Board of Health for action under the "Bense Act," has decided to withhold investigation for the reason that apparently it believes that the local authorities will take care of the situation.

I might say that for the last two months the public water-supply of Cleveland has been continuously very objectionable, and a vast majority of the people, as well as a majority of the newspapers, have been urging filtration. The water, in fact, has not been fit to bathe in for two months, much less to drink. In addition the typhoid rate, although not excessive, has shown a very marked increase over that of 1912. The prospects are that the rate for May, 1913, will be two or three times that of May, 1912.

You see, therefore, there are hygienic as well as æsthetic reasons for purifying the supply. Furthermore, it is the general opinion that the removal of the extreme turbidity of the water is demanded by considerations of more importance than those covered by the word "æsthetic." In other words, we desire water clean enough for bathing purposes.

The inclosed clipping tells something about the commission, and also contains the Mayor's statement. I might add that at the first meeting of the commission yesterday, it was resolved: "That it is the sense of the commission that a filtration plant at Cleveland is necessary in order to secure a safe and satisfactory water-supply at all times."

At this meeting Prof. A. W. Smith, of Case School, was elected president, and the writer was elected secretary. This commission, with the assistance of Mr. C. F. Schulz, superintendent of water-works, expects to submit a general plan with a report and estimates of cost, within a month or two.

With the amount of study which has already been given Cleveland's water-supply, there are many data on hand which will be useful. In addition, the matter of studying the treatment of Lake Erie water by mechanical filters will be taken up first hand by an analyst in the employ of the city, who will make thorough investigations of the eight or nine plants now in operation in the vicinity of Cleveland.

R. W. PRATT,
Secretary Filtration Committee.

Cleveland, Ohio, May 16, 1913.

[Our previous comment on this subject was based on

the fact that the weight of such engineering testimony as was available to us when we wrote, put the burden of proof upon those who demanded immediate filtration. With conditions such as Mr. Pratt outlines we do not wonder that Mayor Baker has concluded that the time for filtration has come and that he has appointed a committee to decide what type of filter is best suited to the needs of Cleveland. Besides Mr. Pratt this committee includes Dr. A. W. Smith, professor of chemistry at the Case School of Applied Science; Dr. Hippolyte Gruner, Professor of Chemistry at Adelbert College, Dr. Wm. T. Miller (local), member of the Ohio State Board of Health and Roger C. Perkin, city bacteriologist.—ED.]

The Value of a Binder Course in Bituminous Pavements

Sir—The Association for Standardizing Paving Specifications, at its fourth annual convention held at Pittsburgh, Penn., Feb. 24 to 27, 1913, after careful consideration unanimously determined that fine bituminous mixtures like "Topeka" specifications should be laid on a binder course in the same way as other sheet-asphalt-sand mixture surfaces.

The report of the committee of the above association on bituminous concrete paving specifications, which was unanimously adopted by the association, referring to such fine mixtures under the heading "Binder Course" contains the following:

> The binder course for macadam base shall be composed of a layer of coarse clean stone of a size to pass a 2- to 2½-in. ring and be retained on a 1-in. ring; it shall be evenly distributed over the surface of the macadam base described above and 1½ in., or practically only one stone deep and rolled until the stones are practically level and forced partially into the macadam base. The rolling should be comparatively light, only enough to partially embed the stone and set them firmly in place without crushing them or forcing the fine material up from below to completely fill the voids. This rolling should be done while the macadam base is still moist and comparatively soft. The stone of the binder course may be laid on without any coating or application whatever or second, with an application of light bitumen after laying and rolling or third, coated with bituminous cement before being laid; when a concrete base is used the binder course shall be laid in accordance with the standard specifications for sheet-asphalt pavements.

The above association in standardizing and insisting upon the use of a binder course under all sheet-asphalt surfaces, including the fine mixture asphaltic concrete or so called "Topeka" specifications, are acting in accordance with what actual practice has demonstrated to be the most standard forms of street-pavement construction.

It has been my experience with the above type of wearing surface that creeping and shoving will take place even under moderate traffic unless a binder course is used. The binder not only prevents this displacement but adds support and stability to the wearing surface, which, owing to its composition being mostly sand, does not have the traffic-resisting qualities within itself.

The value of the binder course was brought out very clearly in a paper read before the American Society of Municipal Improvements in Dallas, Texas, by Mr. Isaac Van Trump, Engineering Chemist of Chicago, in which he says, in effect: "On streets where traffic is medium to heavy, sheet-asphalt pavements or even the fine stone asphaltic-concrete wearing surface now being laid in many localities will frequently creep and shove alarmingly when laid without a binder course."

The committee appointed by the League of California Municipalities to make a study of the best practices in pavement and roadway building made an exhaustive study of the merits of the binder course and reported strongly in its favor for the type of wearing surface now under discussion and so it appears to me that the practice of eliminating the binder course in asphaltic pavements in order to slightly reduce the first cost of the pavement is not in accordance with the best practice in street-pavement construction.

F. N. BINGHAM,
Engineering Chemist.
Merchants' Trust Bldg., Portland, Ore.
Mar. 17, 1913.

The Karns Tunneling Machine

Sir—I have been interested in the description in your issue of Mar. 6, of the Karns tunneling machine. Apparently this differs from most of the others in having actually bored a fair length of tunnel. The point of most interest, however, in all these schemes is the disposal of the muck and the method of accomplishing this is not even hinted at in your description. Most of the machines which have been previously proposed will advance a heading a foot or so, then they get clogged up.

F. LAVIS.
499 Cangallo, Buenos Aires, Apr. 12, 1913.

[We referred the above letter to the Karns Tunneling Machine Co. and append their reply.—ED.]

Sir—In reply to the inquiry as to the disposal of muck, we have always washed this out. Water is pumped in through pipes and at the heading under the machine at the proper points fixed nozzles are located and water is expelled from them under pressure. The rock as it is cut and falls is caught and washed back. Formerly we washed it all the way out of tunnel, nozzles being set in the pipe line at different points as the tunnel progressed, giving new impetus to the flowing water and muck. Later we washed the muck out through a 5-in. pipe line. A funnel shaped to the curvature of the tunnel was located under the machine and near the heading. This funnel was large and caught all dirt and water as it came back. The funnel was connected with our five-inch line and all was confined in it, thus giving much greater force to the flow of the water and cut rock it was carrying. This worked very satisfactorily and carried the muck out nicely. This plan was followed at Johnstown, Penn., back of our 6-ft. machine and did its work well.

Our new machine drives 12 ft. without stopping to move up the holding columns. The machine at Johnstown had to be moved up every 6 ft. of tunnel driven. The new machine also contains many improvements to facilitate operation, suggested by actual operation of previous machines.

In the matter of water available to wash out muck, there must be enough available to keep the dust down in the heading and to wash the muck back and free of the machine, where if sufficient water is not available to carry it on out, it can be loaded into cars or taken out by different methods. Even if a small amount of water is available it can be made to suffice by using the

same water over and over. This is accomplished by making two sumps. The water is pumped from the outer sump and the cut rock and water flows back into the first sump. Before starting the machine under such conditions, the pumps are started and when the water has reached the heading and has returned to the sump, overflowing out of the first into the second, the machine can be started, as the water has made the complete circuit and will flow into the sump as fast as it is pumped out. We adopted this plan at a point in Colorado and accomplished the results with a very small supply of water flowing naturally from the tunnel.

We expect to have one of our smaller sizes of machines in operation on contract work probably during August next. The shops manufacturing it are hurrying it through. The operation of our new and larger sized machine will follow later.

THE J. P. KARNS TUNNELING CO.,
SHIRLEY DAVIS, Secretary.
10410 Lake Ave., N. W., Cleveland, Ohio.
May 13, 1913.

Notes on Stream Gaging Stations

Sir—I have read with interest the article on Stream Gaging Stations by John C. Hoyt in your issue of Apr. 24, 1913.

He speaks of the cost of a station with the most modern equipment as being from $1000 to $1500. There are very few stations where I believe this expenditure would be justified. I have seen several stations equipped with a satisfactory self-recording device for less than $100.

Speaking of comparative runoff, it is pretty generally recognized that the minimum rainfall will be around one-half the average and the maximum runoff will be around twice the average. Under these conditions it is certain that the runoff will vary by nearer 200% than 100% above or below the mean annual average. Also consider two dry years coming together with (we will assume) the same amount of rain, the runoff of the second dry year will probably be nearer two-thirds of the first dry year, other things being equal, except that the watershed is a great deal drier the second year. On the other hand, if two wet years come together with the same amount of rain, the runoff of the second year may be one-third larger than the first, owing to the watershed being in better shape to turn the water off.

Last year I had a gage on a small stream draining about 14,000 acres of high, steep, rocky country which turned off 1.2 ft. in depth of water. Another and adjoining stream draining about 28,000 acres of lower, flatter country, largely covered with soil, only turned off 0.3 ft. in depth of water. The year was a dry one.

There is no question in my mind but what a self-recording gage or Nilometer makes, under ordinary conditions, the only reliable record of stream heights, unless hourly readings are taken, which is usually impossible. The ordinary practice is to take a reading in the morning and one in the afternoon. Usually these two are averaged and from this the discharge is taken from a runoff diagram; or the discharge is taken for each gage height and added together, which will give the discharge in acre-feet or half of it the mean discharge in second-feet. It is assumed that the diagram reads to second-feet. In checking over old records extending over a period of several years which were computed by the first method I have often found that the second method would give an increase of 15% to 50%, but there are conditions which would show a decrease. I believe that the second method is the most accurate.

Another trouble with depending wholly upon the morning and evening readings is that it is impossible to get the maximum and minimum gage heights and the length of time the stream stood around each point. If the station is near the source of a small watershed the crest may come in the middle of the afternoon. The station may be far enough downstream so the crest will come in the night, and the morning and afternoon reading will be about the same. All of the above conditions will give a "discharge" under the actual. If the crest came at the time of the morning or afternoon reading the discharge given would probably be more than the actual.

Again there may be lakes, interior drainage basins on canals taken out above the station, which may not be considered in making up the annual discharge, but which might be turned to account by a different plan of operations.

If the station is located near a house it is customary to employ one of the occupants as observer, at say $5 to $10 per month or 25c. to $1 per reading. Then there is a question if the observer will always take his readings on time or if it is not easier to guess at it. On the other hand, if a regular observer is employed to look after several stations, it is usual for him to make one round in the morning and another one in the afternoon. Almost invariably several hours will elapse between the time he takes his first and last reading on each round. This puts a difficult equation in the problem.

If a good self-recording gage is used it is possible to get a continuous record of the gage heights and as it only requires visiting once a week to change the paper and wind up the clock, it is possible to employ a better man, say, the hydrographer, who can do this in connection with his meter work. This all tends to give a better, more accurate and usually a cheaper record.

The ordinary specifications for a gaging station are:

(1) A fairly smooth and straight channel with fairly permanent banks and bed. The banks not liable to overflow. A place to put the gage where it is not apt to be washed out.
(2) A cross-section of channel fairly uniform for a reasonable distance above and below the gage, with no obstructions to cause backwater rapids, falls, marked eddies, cross currents or boils.
(3) A measurable and uniform velocity of current.
(4) The gage should be placed where suitable arrangements can be made for keeping the gage heights and rating the stream.

I have seen stations where some or most all of the above specifications were disregarded and new stations selected in the immediate vicinity showed very different results, sometimes varying by 100% from the old station records on which comparative records were kept.

Another source of errors is the current meters. They are very delicate and are used under trying conditions. They often receive hard raps. They should be frequently rated.

Very often the ripple on the gage causes an ordinary observer to add 0.1 ft. to the gage height.

I would suggest that in addition to just turning in the results of the observations the following be included in the reports:

(1) A map of the watershed, contoured if possible, show-

ing the locations of the gaging stations, rainfall stations, etc., forests, etc.

(2) A profile and contoured map to a large enough scale to show details of the immediate vicinity of the station.

(3) A good photo or two of each station, showing it at high and low water.

(4) A detailed statement of the methods employed in reading gage heights, current-meter reading and computations.

CHAS. KIRBY FOX.

Pomona, Calif., May 1, 1913.

The Status of the Engineer, A Suggestion from a Young One

Sir—The report, in your issue of Apr. 24, of the discussion at the meeting of the American Institute of Consulting Engineers of the status of the engineer was very interesting to me in showing the opinions the heads of the profession hold of us young "dubs."

There are a lot of us who "may have had engineering schooling, and * * * * * held a leveling rod, or inspected materials," who are anxious to learn what an engineer should be and know, and who have imagined that these small tasks were the beginnings on the road that leads as far as a man's ability will carry him.

If we didn't think so, it's a "cinch" we wouldn't take the jobs at the wages we do, when we could make twice as much with a brick-mason's trowel.

When our college chums, of a couple of years ago, in the "Medic. Dept." finished their schooling, they were Doctors—young, inexperienced, perhaps some of them "bonehead," but to the public—Doctors. But we are not Engineers, at least not "real Engineers," and hardly "young Engineers"; though I rather imagine that our school training was more valuable professionally.

Where lies the difference? Not in the fact that, almost to a man, we went to work on a salary; for many and many of them did the same, with insurance companies, railways, mining companies, or other large corporations. As for that, the entire membership of one profession, the clergy, work for salaries.

The retaining fee does not appear to make a professional man any more than belonging to a profession makes a man competent. And there are many objections to making the retaining-fee idea the criterion of membership in the profession. Military engineers who are an ornament to the engineering profession would be barred out, if acceptance of a salary were disqualifying.

It appears that the "one thing needful" is the one thing common to all the other professions, some definite method of admitting a candidate to membership in the profession. In my humble opinion it would be vastly better if this were managed entirely by "home rule," as with the clergy, rather than by the state, as in medicine and law.

Why could not a national organization of engineers hold annual state examinations similar in purpose to the bar and medical examinations, and formally admit the successful candidates to membership in the profession?

And as for these youngsters grabbing all the business by virtue of their titles—that is quite too good to be true. I presume that the men who have in hand the expenditure of large sums for engineering work are not so foolish as to let some greenhorn waste their money for them.

I cannot see how we youngsters would "get anything" by the organization of the profession except perhaps, a chance to pay some registry fees. It would probably have an effect in lowering our wages still more. But we'll stand the gaff, if it will raise the engineer, "real" or imaginary, in the estimation of the public.

F. YOUNG.

Hibbing, Minn., May 6, 1913.

The Pitot Tube Formula

Sir—Mr. John Airey gives some very correct notes on the Pitot tube in your issue of Apr. 17. This is a good time to lay bare some of the inaccuracies concerning the theory of this instrument which have appeared and still continue to appear in some of our best books. Bernoulli's Theorem applies to streamline flow, and even in practical cases the coefficient of the Pitot tube in the formula $h = \frac{v^2}{2g}$ is substantially equal to unity.

The writer is not certain as to the effect of turbulence upon the Pitot tube. He is inclined to believe that, on the average, the effect is to leave the coefficient practically unchanged. In 1911, during a series of turbine tests, about 100 velocity comparisons were made between simultaneous velocities determined by means of a Haskell current meter and Pitot tube in the tailrace (see current number of Trans. Am. Soc. C. E.). These velocities were observed at 60 points in the tailrace at 5 different depths, 12 points at each depth. The ratio of the sum of the velocities by the Pitot tube so that by the Haskell meter was 1.004, but the variations from unity in the ratio of corresponding individual velocities were in some cases as much as 5% or 6%, due to errors of observations and irregularities of flow. The observations were not conducted with laboratory precision, since the inequalities of velocity encountered caused vibrations of head and rendered it necessary to take twenty or thirty readings in order to eliminate accidental errors of this kind. It is, therefore, apparent that the coefficient of the tube employed in a very practical case was unity.

Further information on this interesting subject may be had by reference to a paper by W. M. White, entitled "The Pitot Tube: Its Formula," Journal of the Association of Engineering Societies, Vol. XXVII, 1901, p. 35. This paper confirms the work of a number of experimenters, among whom may be mentioned, Darcy and Bazin (1865), John R. Freeman, Gardner S. Williams and L. F. Moody.

It seems hardly proper to say that the momentum theory is untenable, since that theory is the rock upon which all engineers must build. In fact it is the basis of Bernoulli's Theorem itself. It would seem to describe the case better to say that errors have been made in the premises upon which to base reasoning concerning the theory of the Pitot tube with the result that the formula deduced required twice as much pressure as demanded by the nature of the case.

Mr. Airey's conclusion (f) is by all means very true. There are two parts to a Pitot tube, namely; the dynamic orifice and tube (Pitot tube proper), and the static orifice and tube. The coefficient of the former, *when of circular section and whether cylindrical, diverging, or converging, is unity.* But the latter, if improperly designed, may fail to indicate the true static pressure.

B. F. GROAT.

2402 Oliver Bldg., Pittsburgh, Penn.
Apr. 29, 1913.

Reports on Filtering the Croton Water-Supply

SYNOPSIS—A twenty-year campaign for improving the quality of the Croton water-supply, New York City, is reviewed, with particular reference to recent engineering and other reports on filtration plans and the need for filtration. An account is given of the action of the Bureau of Municipal Research and the Citizens' Union to prevent the award of a filtration contract to the lowest bidder of Jan. 23, 1913, and of Comptroller Prendergast to the same end. Of two boards of engineers who have passed on the present contract plans all approved them as to character and one only dissented as to the advisability of filtration—a question raised after bonds had been authorized, plans prepared and bids advertised.

The remarkable hold-up of the proposed contract for a 320,000,000 to 400,000,000-gal. mechanical filtration plant for the Croton water-supply, New York City, together with questions raised at the eleventh hour and fifty-ninth minute as to the need of a filtration plant anyway, involves many points of general interest.* We have, therefore, prepared a general review of the twenty-years' agitation for an improvement of the Croton water-supply, a summary of the main features of the controversy, and also abstracts of reports on filtration made in June, 1912, and April, 1913, by two boards of consulting engineers, headed, respectively, by Allen Hazen and Nicholas S. Hill, Jr.

In the early eighteen-nineties the New York State Department of Health made a detailed sanitary inspection of the Croton drainage area and published a voluminous report, illustrated by hundreds of pen sketches from photographs, showing gross pollution of the Croton supply. Since then immense sums of money (see statement near close of this article) have been spent in acquiring land for the sanitary protection of the Croton water-supply, considerable sanitary inspection has been carried on by the city authorities and other watershed remedies have been applied. Coincident with this and gaining strength with time, there has been a demand for the filtration of the Croton water-supply.

By way of statement of this growing demand, and of technical sanction for it, we cannot do better than to condense a statement made in 1911 by three members of the then and present Board of Estimate and Apportionment (the central governing body of New York City):*

The committee stated that there had been a practically unanimous opinion among "the authorities" that the Croton supply "should be filtered as a sanitary measure and to improve the appearance, taste and odor of the water"; that in 1903 the Burr-Hering-Freeman Commission had advised the immediate filtration of Croton water; that in 1904 J. Waldo Smith, then chief engineer of the Croton Aqueduct Commission, advised, and Prof. Wm. H. Burr indorsed, that work on the easterly basin of the Jerome Park Reservoir be suspended, awaiting the determination of the filtration question; that the city health department had repeatedly urged filtration; and that filtration of the Croton supply had been advised in a report [1904] by Hazen & Whipple, who stated that "the water-supplies of many cities formerly inferior to those of New York are now as good or better because of purification works."

On May 23, 1906, the Board of Estimate directed the Commissioner of Water Supply to select a site and prepare plans and specifications for a filtration plant. In March, 1907, an experimental or testing station was put in operation. On Oct. 30, 1907, John H. O'Brien, then Commissioner of Water Supply, and I. M. de Varona, Chief Engineer of the Department of Water Supply, reported to the Board of Estimate, submitting plans for a 400,000,000-gal. slow sand filtration plant operating at the rate of 10,000,000 gal. per acre at the Jerome Park site already mentioned. This report was indorsed by Hering & Fuller, of New York City. Wm. B. Fuller had been engaged on the plans and specifications thus indorsed. The experimental work mentioned consisted of tests of sedimentation, slow sand filtration without and with coagulants and ozone treatment of water which had been passed through a Hungerford mechanical filter. (See ENG. NEWS, Nov. 1, 1907, p. 561, for abstract of the report just mentioned, and pp. 556-7 for editorial comment on the report.)

It was urged upon the Board of Estimate at that time that if it would promptly make an appropriation, filtration works might be completed in 1909. Opposition to this program was made by H. A. Metz, then City Comptroller of New York, and the project was dropped—partly, perhaps, because of the financial stringency of 1907.

On July 29, 1910, the Board of Estimate authorized

*The hold-up began early in the present year, but bids were finally received on Jan. 23, with the understanding that no award would be made until after the opponents to filtration had had opportunity for investigation. The plant as designed would have a nominal capacity of 320,000,000 gal. and a maximum capacity of 400,000,000 gal. a day. Further particulars are given by the folowing extract from the specifications:

The filter plant consists of 80 filters of the mechanical type, a head house, a mixing chamber, settling basins, filtered-water reservoir and appurtenances.

The excavation is partly in earth and partly in rock. Much of the excavation for the basins and reservoirs has been done under a previous contract.

The filters are supported on the roof arches of a portion of the filtered-water reservoir, and are furnished with operating galleries, piping, wash-water reservoir and complete equipment. The filters have a net area of sand surface of about 2.7 acres. The superstructures over the filter galleries are not included in this contract.

The mixing chamber is a covered concrete reservoir having an area of about 0.9 of an acre, provided with interior baffles, flushing pipes, drains, etc. Its purpose is to thoroughly mix the chemicals with the water.

The setling basins consist of six covered concrete reservoirs having a total area of about 11.2 acres. Five are for removing the heavier sediment from the water before it passes to the filters, and are provided with baffles. One is for removing the sediment from the wash water if required. All are provided with flushing pipes and drains.

The filtered-water reservoir consists of a covered concrete reservoir having an area of about 55 acres in addition to the portion beneath the filters.

All the basins and reservoirs are covered with earth and grassed.

The head house is a reinforced-concrete building consisting of concrete foundation, frame and roof, about 100x160 ft. in size, part of which is three stories high and part two stories high. The outer walls and the partitions, plumbing, heating and lighting are not included in this contract. The head house contains bins, tanks and apparatus for the storage and handling of the chemicals to be applied to the water.

Two main gate chambers are located, one at the north and one at the south end of the settling basins. Three gate chambers are located in the filtered-water reservoir. The superstructures of these buildings are not included in this contract.

*It is interesting to note that one of these men was Comptroller Prendergast, the present official arch-opponent of filtration; another President McAneny (Borough of Manhattan), who is reported to have joined Mr. Prendergast in his opposition; and the third, Mr. Mitchel, President of the Board of Aldermen, who has voted (test vote) in favor of filtration, but who the opponents hope to win over on the proposed day of final action, May 22. The three men reported in 1911, in favor of the very bond issue which Mr. Prendergast has been trying since January of this year to annul.

a bond issue of $2,200,000 for completing the easterly basin of the Jerome Park Reservoir, including foundations for a filtration plant to be built above the reservoir at some future time. On Nov. 18, 1910, the Board of Estimate appointed three of its own members a Committee on Filtration to consider both the filtration of the Croton water-supply and a proposition for disinfection, the latter having been submitted by Wm. B. Ellison, on behalf of the New Jersey Securities Co.

On Jan. 26, 1911, Commissioner of Water Supply, Thompson, requested the Board of Estimate to authorize $6,500,000 more bonds, in order that a filtration plant might be built in connection with the completion of the east basin of the Jerome Park Reservoir, authorized on July 29, 1910. This request was referred to the Committee on Filtration, already mentioned, and also to the Corporate Stock Budget Committee of the Board of Estimate. The last of these committees waited on the first one for a report on both disinfection and filtration, but as the Committee on Filtration failed to act it was discharged in April, 1911, at the request of Commissioner Thompson.

This action having cleared the field, the Corporate Stock Budget Committee (Wm. A. Prendergast, Comptroller, and Messrs. Mitchel and McAneny) reported to the Board of Estimate on Apr. 12, 1911, in favor of cutting the $2,200,000 loan previously authorized to $10,000 and granting a new joint loan of $8,690,000 for completing the east basin of the Jerome Park Reservoir and building a sand filtration plant in connection therewith. This recommendation was adopted by the Board of Estimate on May 11, 1911. At the same time the qualifying word "sand" was stricken from the resolution, thus leaving the type of plant open. On June 20, following, the Board of Aldermen concurred in this bond authorization, which has been the basis of action from that time until this.

In Commissioner Thompson's request of Jan. 24, 1911, in the Corporate Stock Budget Committee report of Apr. 12, 1911 (virtually approved by the Board of Estimate), and in a memorandum submitted to the Board of Aldermen by a committee of that body, the need for filtration of the Croton water-supply was stated in strong terms. The Board of Estimate authorized the filtration bonds without a dissenting vote and the Board of Aldermen by a vote of 50 to 1.

In view of Comptroller Prendergast's recent action in holding up filtration it is interesting to note the following statement in the report of Apr. 11, 1911, which bears his signature:

> Your committee believes that the Croton water-supply should be filtered and that the filter plant should be built as a part of the contract for the completion of the easterly basin of the Jerome Park Reservoir, if it is ever to occupy that site.

The committee also outlined the various earlier recommendations for filtration, as summarized at the beginning of this historical sketch.

Soon after the authorization of bonds on May 11, 1911, the Department of Water Supply engaged George W. Fuller, of New York City, as consulting expert for filtration and Elmer G. Manahan, formerly with Hering & Fuller, as division engineer in immediate charge of filter design. A force of twenty-five engineers and draftsmen was engaged and work actually prosecuted on designs and estimates for both slow sand and mechanical filtration plants. These special filtration engineers and I. M. de Varona, Chief Engineer of the Department of Water Supply, concluded that mechanical filtration would be cheaper than slow sand filtration, in construction cost, by some $3,000,000. It may be noted in passing that between 1907 and 1912, material advances were made in mechanical filtration and it may be further noted that the slow sand filtration estimates of 1907 were based upon a scheme of mechanical scraping of slow sand filters which has since been proved, by experience at Pittsburgh, to be less successful and economical, to say the least, than was expected.

In order to make assurance doubly sure a Consulting Board of Experts was appointed by Henry S. Thompson, Commissioner of Water Supply, to examine the 1912 filtration plans.* This board reported to Mr. de Varona on June 10, 1912, and on June 25, the report was transmitted to the Board of Estimate, which, through a committee, and after approval by its engineers, authorized the Department of Water Supply to advertise for bids.†

For reasons unknown to us, proposals were not invited until about Dec. 1, 1912. The advertisement for bids appeared to have attracted the attention of the Bureau of Municipal Research and the Citizens' Union and to have led them to look into the plans and specifications, whereupon they seemed very soon to have concluded that the specifications were not in the interests of the city in a number of respects, and that, moreover, there was serious question as to whether or not the particular plan of water purification proposed was the best one for the city. The latter opinion was based largely upon what the civic investigators regarded as a halting approval of the filtration plant by the Consulting Board of Experts. On Dec. 31, 1912, Henry Bruére, a director of the Bureau of Municipal Research, submitted objections to the project to Comptroller Prendergast.

On Jan. 8, 1913, Comptroller Prendergast reported to a meeting of the Board of Estimate and Apportionment a statement to the effect that the whole subject of these

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*Allen Hazen, chairman, George A. Johnson, secretary, Frank A. Barbour, Prof. Wm. G. Mason and James H. Fuertes; Mr. Barbour being of Boston, Prof. Mason of Rensselaer Polytechnic Institute, and the other three being of New York City.

†As some of the events connected with this committee investigation figured largely as reasons for the later hold-up of the filtration project, we summarize them in this footnote for the benefit of those who care for the details:

Vacation time being near, during which it would be impracticable to get together a majority of the Board of Estimate, and the Department of Water Supply being anxious to be in a position to advertise for bids for filtration work, the Board of Estimate on July 15, 1912, appointed five of its own members as a Committee on Filtration, with power to act in behalf of the full board. This board consisted of Mayor Gaynor, Comptroller Prendergast, and the Borough presidents of Manhattan, the Bronx and Richmond. On July 23 this committee referred the general question of the adequacy and sufficiency of the mechanical filtration plans and specifications to Nelson P. Lewis, chief engineer of the Board of Estimate and Apportionment, and to Chandler Withington, principal assistant engineer, Department of Finance (the department presided over, we understand, by Comptroller Prendergast). On July 29, these engineers reported back to Mayor Gaynor a general indorsement of the plans and specifications, subject to minor changes in the latter.

On Aug. 1, Mr. Lewis reported to Mayor Gaynor that he had been informed by the Commissioner of Water Supply that some question had been raised as to the loss of head that would be caused by the proposed filters and after investigation he had concluded that this loss of head (5½ ft.) might be disregarded as being a minor consideration.

On Aug. 8, 1912, Mayor Gaynor wrote to the Commissioner of Water Supply to the effect that the special committee on filtration for the Board of Estimate had held three hearings and had approved the filtration plans and specifications, with the modifications suggested by Mr. Lewis. In effect, Mayor Gaynor also stated that all the formalities required from the Board of Estimate had been complied with and that the Commissioner of Water Supply was therefore authorized to advertise for proposals. In the same letter the Mayor stated that certain questions relating to patents had been given consideration and had been covered by a recommendation of the legal department of the city.

specifications, and of filtration as well, needed further study. His statement was accompanied by a resolution cutting down the appropriation of May 11, 1911, from $8,690,000 to the sum of $50,000, the latter to be used under the direction of the Commissioner of Water Supply for "making tests of various types of filters and filtration plants." This resolution was not passed. Instead, the Department of Water Supply was allowed to open the filtration bids on Jan. 23, 1913. The totals of these bids, as canvassed by Mr. De Varona, are given further on in this article; bids in tabular detail were published on page 42 of our Construction News section for Feb. 13, 1913.

At a later date a committee of the Board of Estimate appointed the Advisory Commission of Engineers already mentioned, a majority of which reported in favor of the filtration plans late in April, 1913.

On May 8, 1913, a committee of the Citizens' Union submitted a communication to the Board of Estimate, urging it that no contract for filtration be "awarded at this time" and that it annul the filtration appropriation. The committee also stated that it intended "to bring a taxpayer's action to test the legality of the proposed contract," which it instituted on the afternoon of the same day. On the following day Commissioner Thompson replied to the Citizens' Union brief and to the minority report of the advisory engineers. On May 13, the Board of Estimate, at a special meeting and on a test vote, voted 10 to 6 in favor of awarding the filtration contract to the lowest bidder, but when the matter came up for final action on May 15 the subject was postponed for a week.

Having reviewed the history of the filtration project, we will now take up the report of the Consulting Board of Experts submitted June 10, 1912. We will then give some of the specific allegations or objections of the Bureau of Municipal Research and of Comptroller Prendergast, an abstract of the reports by the recent Advisory Commission of Engineers, make further reference to the protest of the Citizens' Union, filed on May 9, and summarize reports submitted on May 20 by Allen Hazen and Geo. A. Johnson. Elsewhere in this issue editorial comment on the hold-up may be found.

Report of Consulting Board of Experts, June 10, 1912.

The report of the Consulting Board of Experts opened with a formal introduction and with acknowledgments to Messrs. Geo. W. Fuller, E. G. Manahan, D. D. Jackson and Geo. C. Whipple. The balance of the report was as follows:

We have taken up first a discussion of the general principles involved, but on account of engagements of the various members of your Board, and the short time allowed for the making of this report, we have not been able to push our inquiry along several lines as far as would reasonably be necessary in order to answer to our full satisfaction some of your questions.

We assume in making this report what we believe to be the case: that the work of preparing these plans and projects has been well and carefully executed; that the calculations are correct; and that the design is generally good as relating to all the many details which we have not had time to take up. We believe that your engineers are fully competent in this respect, and express at this time our confidence in the general results, which, owing to the limitations above noted, we have not been able to check fully.

From the memoranda submitted to us, it appears that the proposed filtration works are to be located at the Jerome Park Reservoir site as determined by the Board of Estimate; that the plant is to have a capacity of 320 million gallons per day and is to be capable of treating 400 million gallons at times; and that the filtered-water reservoir, when full, will have its flow line at Elev. 126 and will contain 365 million gallons. We understand that the scope of our duties is limited by these premises.

We also note that while the report and plans prescribe a system of sand filters, as well as a system of mechanical filters, the latter system has been adopted by your Department as most suitable for the local conditions.

We further note that it is proposed to apply regularly a sterilizing treatment to the filtered water, and that soda or lime will be added whenever desirable, in order to remove free carbonic acid, and thus lessen the corrosive action on iron pipes.

We have also been told that it is the intention to use copper sulphate systematically and thoroughly in Croton Lake, for the purpose of reducing and preventing growths that would otherwise cause objectionable tastes and odors.

We will now take up the questions and answer them in the light of our judgment and such evidence as we have been able to collect.

Mechanical Filters

(1) Are the mechanical filters as shown by the plans of the Department in accordance with modern practice?

Modern practice in filtration is variable and must be so because of the different conditions that have to be met. In this case some of the conditions imposed are unusual, and any plans that could reasonably be proposed to meet them would have unusual features.

Taking these matters into consideration, we answer by saying that the mechanical filters shown by the plans are in general accordance with modern practice.

(2) Will these mechanical filters properly purify the water and render it clear and colorless?

We believe they will.

Mechanical filters of the type that is proposed can be depended upon to remove all turbidity and color from Croton water.

We understand that it is part of the plan to treat continuously the effluent with hypochlorite of lime, and this will insure a high degree of bacterial purification.

We further understand that it is the intention, and must be considered as an integral part of the project, to treat the water of Croton Lake systematically and thoroughly with copper sulphate, with the idea of suppressing certain growths which otherwise would give rise to troublesome tastes and odors, which could not be sufficiently removed by the filters that are shown by the plans.

We are in doubt as to the possibility of using copper sulphate in Croton Lake and operating the proposed filters so as to produce at all times a water as free from tastes and odors as we believe the effluent should be, to satisfactorily serve the people of New York City.

We therefore suggest that an aërating plant, possibly near the Pocantico cut, might be of material assistance at times in reducing and removing tastes and odors. To carry this out it might be possible to utilize about 20 ft. of head as a minimum under ordinary circumstances for aëration, fixing in connection therewith the minimum ordinary level of Croton Lake 20 ft. below the spillway level. The question as to whether this 20 ft. would give sufficient storage capacity for the summer floods to be reasonably anticipated, thereby permitting the system to be used without substantial sacrifice of ultimate capacity, is one which we have not investigated, but which can easily be taken up by your engineers.

We believe that if it were possible to arrange the inlet so as to draw bottom water, and to aërate it at Pocantico cut or elsewhere, before going to the filters, that the project would be much improved from the standpoint of certainty of delivering water acceptably free from tastes and odors. It appears that the engineering difficulties of arranging an inlet to secure only bottom water and deliver it through the present tunnel are very great.

It is suggested that studies should be made to throw more light upon the character of water in Croton Lake at different levels and as drawn by the aqueduct through the various outlets that could be used; and that experiments upon the effect of aëration and treatment by the proposed process upon the different kinds of water that may be so encountered at all seasons of the year should be carried out while the works now proposed are under construction.

(3) Are the estimates of cost of constructing these mechanical filters reasonable?

We have not been able to check over these estimates in detail, but from our general experience it appears that they are reasonable.

(4) Is the estimated cost of operation of these mechanical filters reasonable?

We believe that the estimated cost of their operation is reasonable.

Sand Filters

(1) Will it be necessary to use coagulants in order to obtain clear and colorless filtered water at all seasons of the year?

We are of the opinion that in order to produce clear water, and water that is sufficiently colorless to be satisfactory at all times, with sand filters, it will be necessary to use coagulant for a portion of the time; that is to say, whenever the water is turbid and when the color is high.

(2) Are the sand filters as shown in the general plans of the Department in accordance with modern practice where coagulants are to be used?

We find this one of the most difficult of your questions to answer. The site that is proposed, if it had been left in its natural condition, would have been an excellent one for the construction of sand filters. It was excavated years ago for another purpose to a depth of 15 ft. or more below the natural foundations for such filters. To use it for sand filters at this time involves filling it up in some way so that the filters may be supported at the required elevation.

The method proposed by these plans for reaching this end is to build a system of concrete piers and arches. A structure of this kind is necessarily more expensive than anything ordinarily involved in the construction of sand filters. It also may represent an element of weakness, due to movements of the masonry from any cause, especially with unequal loading that is very difficult to avoid.

The use of the space underneath the filters as a part of the pure water reservoir is nominal only. The water stored cannot be used, because it is, all of it, lower in elevation than would suffice to make it available.

Passing all other questions of design, we feel that it is open to doubt whether the Jerome Park site can be considered at the present time as one permitting of suitable plans for sand filters of such type as we should be willing to call generally in accord with modern practice.

(3) Will these modified sand filters properly purify the water and render it clear and colorless?

The answer to this question would be in general the same as the answer to question No. 2 under mechanical filters. The filters will render the water clear and colorless. With the use of hypochlorite of lime in the effluent it will be of excellent hygienic quality. But the use of copper sulphate in Croton Lake to hold down the growths of organisms is a necessary and integral part of the project, and we are disposed to believe that even with copper-sulphate treatment carried out to the greatest possible extent there would be objectionable tastes and odors in the effluent at times.

As with mechanical filters, an aërating plant would be helpful in dealing with these tastes and odors.

(4) Are the estimates of cost of constructing these sand filters reasonable?

The ansyer to this question is to a considerable extent involved in the answer to question No. 2. We have no cause to doubt the estimates that have been prepared for these structures are reasonable. Compared with the cost of constructing sand filters upon more favorable sites, these estimates are very much higher.

(5) Is the estimated cost of operation of these sand filters reasonable?

We believe that the estimate is sufficient.

We are disposed to think, in the light of recent results obtained elsewhere, that it may be possible to considerably reduce the amount of coagulant required, and the cost of operation. This matter, however, in view of circumstances previously outlined, appears to have but little significance at the present time.

This completes, as we understand it, the answers to the questions you have propounded.

(Signed) ALLEN HAZEN, Chairman,
GEORGE A. JOHNSON, Secretary,
FRANK A. BARBOUR,
W. P. MASON,
JAMES H. FUERTES.

By some chance, or mischance, it appears that only Mr. de Varona's summary of the foregoing report went to the Board of Estimate, a point to which reference is made later on.*

*The full report did go to Messrs. Lewis and Withington, engineering advisers of the Board of Estimate and Finance Department. Mr. de Varona's summary was as follows:

They report that "the mechanical filters shown by the plans are in general accordance with modern practice."

That they believe they will properly purify the water and render it clear and colorless.

That the estimates of cost and operation appear to them to be reasonable.

That, "In order to produce clear water, and water that is sufficiently colorless to be satisfactory at all times, with sand filters, it will be necessary to use coagulants for a portion of the time."

That "it is open to doubt whether the Jerome Park site can be considered at the present time as one permitting of suitable plans for sand filters of such type" as they should be willing to call generally in accord with modern practice.

These conclusions fully establish those of the preliminary report made by me to you, in which the construction of mechanical filters was advocated.

The suggestions made by the Board as to aëration, use of sulphate of copper, etc., are in accordance with the views of this Bureau and will receive due and timely consideration.

MEMORANDUM OF THE BUREAU OF MUNICIPAL RESEARCH
Dec. 31, 1912.

In a letter of Henry Bruére, director of the Bureau of Municipal Research, to Comptroller Prendergast, already mentioned as having been sent on Dec. 31, 1912, Mr. Bruére first expresses the opinion that "the city has not made sufficient investigation of the relative merits of such a system of filtration to warrant its making the large expenditure now contemplated on a mechanical filter plant." He adds that there seems to be no "urgent need for immediate action in the construction of the plant" and asks if it would not be desirable to have filtration experiments made from which "a conclusion may be drawn as to the best type of plant for New York City use." He also alleged that the Board of Estimate had not "made an investigation through its own experts, as is customary in projects involving such a large expenditure."

Mr. Bruére then submitted various "objections to the present form of the Jerome Park filtration project." He first urged that there could not be fair and full competition for those parts of the filtration plant which were covered by patents, since, he alleged, "three of the most important features [central operating control, negative head and strainer system—ED.] in any of the six types specified were patented." He also urged that the entire contract should not be let to one contractor, especially in view of the fact that patented devices were involved.

Other objections were that the specifications gave the engineer discretion regarding the relative amounts of sand and rock in concrete and that the selected site would cause a loss of head of 5½ ft.

After taking up the several points mentioned, Mr. Bruére went into the general question of the filtration of the Croton water-supply. He urged that in 1906 the Department of Water Supply and Chief Engineer Lewis, of the Board of Estimate, had recommended slow sand filtration at this same site and that through "investigation of the Comptroller this project was abandoned" because it was shown "that the estimate of the quantity of water which could be filtered in this way on this site was excessive." Notwithstanding this, Mr. Bruére urged, "now the same department and the same engineer recommend totally different types of filtration plants, namely, mechanical filtration involving the use of chemicals as follows: Alum, milk of lime, hypochlorite of lime, together with sulphate of copper to be used in Croton Lake."

Toward the end of this memorandum Mr. Bruére urged that the Board of Estimate "obtain independent engineering and scientific opinion with respect to this general subject prior to awarding this contract."

REPORT OF COMPTROLLER PRENDERGAST, JAN. 8, 1913.

The so called report of Comptroller Prendergast to the Board of Estimate, dated Jan. 8, 1913, in which he advocated that the filter and reservoir appropriation be cut

down to $50,000 to be used in further investigation, consisted of very little except a brief recitation of the history of the plans and specifications on which bids were about to be received and the plea that owing to haste the filtration plant had been considered by a committee of the Board of Estimate instead of the whole board, and that recently there had been brought to his attention apparent expressions of doubt in the report of the Consulting Board of Experts as to its indorsement of the plans. The Comptroller also stated that he felt convinced that if the Committee on Filtration had read the full report of the Consulting Board of Experts it would not have failed to come to the conclusion that the subject had not been properly studied and that, therefore, it was not fitting to open bids and award contracts. The Comptroller then stated:

I believe in making an expenditure of such magnitude we should exercise extreme care. I believe everyone who has to drink Croton water wants the water filtered, not because it is dangerous, but chiefly because of the unpleasant taste and odor.

If the condition of the water-supply were such as to endanger health, I should not suggest any delay in the construction of the filtration plant.

However, in view of the fact that the public health would not be menaced by delay, I suggest the advisability of a more thorough study of the question of filtration.*

Canvass of Filtration Bids of Jan. 23, 1913.

Before proceeding to take up the report of the Advisory Commission of Engineers, appointed to give the Board of Estimate further light on the subject of purifying the Croton water-supply, it may be noted that nine bids were received for the proposed water filters on Jan. 23 and that these were about equally divided between being higher and lower than the Department of Water Supply estimates, but that the range of prices was remarkably small for a work of such magnitude. For the convenience of our readers we reprint Mr. de Varona's letter to Commissioner Thompson (Jan. 24, 1913), in which he canvasses the bids:

I have received and herewith return the summary of bids submitted on Jan. 23 for the construction of the Jerome Park filters. Nine bids were submitted as follows:

Keystone State Construction Co.	$5,139,015
Luke A. Burke Sons Co., Inc.	5,672,145
MacArthur Brothers & Mason Hanger Co.	5,783,170
Carter Construction Co.	5,885,875
J. F. Cogan Co.	5,934,955
Booth & Flinn, Ltd.	6,094,855
Oscar Daniels Co.	6,160,410
E. E. Smith Co.	6,619,960
The T. A. Gillespie Co.	6,752,500

I recommend the acceptance of the lowest bid, which is that of the Keystone State Construction Co.

The Keystone State Construction Co. are generally recognized as competent contractors for large work in connection with water-supply construction. They have under way, the Hill View Reservoir, under the direction of the Board of Water Supply, the bids for this work having been opened on Dec. 8, 1909, and the contract price being $3,269,280, which was the lowest of seven bids received. On Jan. 1, 1913, the engineers' estimate of work done on this contract was $1,957,782. Work completed on that date was 60% of the total, whereas under the schedule of progress called for in the contract, 50% was required.

While I am informed that these contractors have successfully constructed filters and other large works amounting to over $15,000,000, I recommend that you require the contractors to produce evidence of their resources, ability and experience to satisfactorily complete the filter plant in accordance with the provisions of the contract.

The engineers' estimate for this work was $5,916,700. Of the nine bids received four were lower than the engineers' estimate and five were higher, the average of the nine bids being $6,004,765, which is about 1½% higher than the engineers' estimate. The low bid, that submitted by the Keystone Construction Co., amounting to $5,139,015, is 13% below the engineers' estimate, while the high bid, that of the T. A. Gillespie Co., amounting to $6,752,500, is 14% above the engineers' estimate. For the Hill View Reservoir, which the Keystone State Construction Co. are sucessfully building, their bid was 28% lower than the engineers' estimate.

The bids, both in number and amount, confirm the sufficiency of the contract, specifications, and plans to accurately define and describe the work to be done and the reasonableness of the engineers' estimate for this work. They also show that there has been fair competition.

Report of the Advisory Commission of Engineers, April, 1913.

The report of the Advisory Commission of Engineers on the Jerome Park filter was submitted late in April, 1913, to Wm. A. Prendergast, comptroller, John P. Mitchel, president of the Board of Aldermen, and George McAneny, president of the Borough of Manhattan, these gentlemen being members of the Corporate Stock Budget Committee of the Board of Estimate. As has been already stated, the five engineers agreed on everything except the need of immediate filtration, which was made the subject of a dissenting report by one of the five.

The so called majority report, after discussing the meaning of water analyses, goes on as follows:

Quality of Croton Water

As at present delivered to the consumer the Croton water would be characterized by the water analyst as noticeably colored and slightly turbid, at times quite turbid; at other times containing numbers of microscopic organisms with an odor persistently vegetable and occasionally aromatic, grassy or even fishy; reasonably soft; a good boiler water and generally satisfactory for industrial purposes; ordinarily safe, but at times sufficiently polluted to indicate the possible danger of infection from water-borne diseases.

Physical Quality

While the color, turbidity and odors of a water are not deleterious to health they produce an unattractive water. The Water Department, owing to complaints relating to the Croton supply, issued and published a general statement in September, 1910, and again in March, 1912, for the purpose of assuring people that no harm would result from the disagreeable odors and tastes and the turbidity of the water of which they complained. Evidence of the unattractiveness of the Croton water as supplied to the consumer is found in the large number of local filter plants and in the common use of bottled water.

The microscopic organisms which are found in Croton water have an effect on the water-supply system, which ought not to be overlooked. They serve as food for the various organisms which dwell upon the inside of water pipes and which are often described under the head of "pipe moss." These growths materially clog the pipes and decrease their carrying capacity. They serve as a refuge for many small animals, such as snails, shrimps, crustacea, etc. Sometimes they become detached in tufts when they are liable to clog up the house services. These various pipe dwellers are dependent upon the microscopic organisms for food, not being found in ground water or in filtered water systems. The removal of the microscopic growths from the Croton water will in a large measure remove the objectionable growths from the distribution systems of the city. While the reduction in the pipe growths will not necessarily be immediate, there will eventually result an improvement in this respect due to filtration.

The physical qualities of the Croton water are inferior to the unfiltered supplies of Boston and Cleveland and to the filtered supplies of Philadelphia, Washington, Pittsburgh, Cincinnati, Louisville and many other of the larger cities and towns. Baltimore and St. Louis are about to let contracts for mechanical filtration plants, and upon their completion, will supply a very much better quality of water to the consumer

*The objections of the Citizens' Union, the Bureau of Municipal Research and Comptroller Prendergast, together with replies thereto by Commissioner Thompson, Chief Engineer de Varona and Consulting Engineer Fuller, and a history of the filtration project since 1906 were published early in the present year as a pamphlet of more than a hundred pages. Messrs. Thompson and de Varona pointed out that the objectors had overlooked the fact that filtration experiments had been made in 1906 and detailed studies of filtration from that time until 1912. They also pointed out what they regarded to be gross misconceptions of the engineering points involved in many of the allegations made by the civic objectors.

than is now supplied through the Croton system. Previous to filtration, however, the supplies in these places were probably inferior to the Croton supply.

Sanitary Quality

The Croton watershed has a population of approximately 25,000, a large proportion of which is grouped in small communities, towns and institutions. The majority is to be found in the lower reaches of the watershed, immediately adjacent to Croton Lake. The wastes from this population eventually find their way into the streams which are directly tributary to Croton Lake. There are many visual evidences of pollution in the Croton watershed. It will be instructive to see if the bacterial examinations indicate the effects of the visual pollution. Following is a table giving the results of bacterial examination of the Croton water as delivered at the 135th St. gate house [some distance above the Central Park reservoirs. —Ed.]:

	Bacterial Count				Per cent. of Positive Tests for B. Coli in 1 c.c.	
Year (1)	Annual average (2)	Maximum average for one month (3)	Maximum (4)	Micro-organisms annual average (5)	Average annual (6)	Maximum monthly average (7)
1903.....	1848	.....	.....	.....	19.3	.....
1904.....	1449	10,000	25,000	1058	11.7	36.7
1905.....	2337	12,000	50,000	729	16.0	33.4
1906.....	2084	11,000	33,000	1005	13.5	56.7
1907.....	572	2,000	26,500	1244	8.1	40.0
1908.....	414	800	5,300	897	4.4	23.3
1909*.....	469	700	4,200	1918	11.6	36.6
1910.....	871	4,500	15,200	2348	23.5	93.4
1911.....	1709	5,000	29,000	2310	29.8	70.0
1912†.....	790	2,000	12,000	564	10.1	86.7
Average.....	1254	5,333	22,311	1267	14.8	52.9

* Hypochlorite of lime used since July, 1909.
† Method of making counts changed in 1912 to conform with new standard adopted by American Public Health Association.

An examination of this table shows that the average number of bacteria, according to the standard methods prescribed by the American Public Health Association, is about 1254 per c.c. Furthermore, it is found that for periods of 30 days' duration, the bacterial count is from 700 to 12,000 per c.c., the maximum bacterial count during the past seven or eight years having been as high as 50,000 per c.c.

Comparisons of the figures for Croton water at 135th St. Gate House with the average bacterial count of the water of White Pond and Lake Gilead, both situated in the upper Croton watershed and sources on which there is little or no tributary pollution and which may, therefore, be taken for the purpose of determining the normal bacterial content of the Croton water, show that the number of bacteria normally present in White Pond and Lake Gilead is much smaller than at the 135th St. Gate House. The average bacterial count at White Pond and Lake Gilead has ranged from about 270 to 300, compared with 1254 at the 135th St. Gate House. The increase in bacteria is suggestive of the increased pollution as the water passes down to the city.

For the purpose of outlining some standard of purity for a public water-supply, Prof. W. H. Horrocks, of the Army Medical School of Great Britain, offers the following classification, which he says gives the mean results of a long series of examinations:

> Very good waters contain from 0 to 50 bacteria per c.c.
> Good waters contain from 50 to 500 bacteria per c.c.
> Mediocre waters contain from 500 to 3000 bacteria per c.c.
> Bad waters contain from 3000 to 10,000 bacteria per c.c.
> Very bad waters contain from 10,000 to 100,000 bacteria per c.c.

In the average filter plant, the object to be attained is to produce an effluent containing not over 100 bacteria per c.c. This figure may be exceeded at times when the filters are loaded with heavily polluted water, but the average results should fall within the figure stated.

The analyses further show that during the years 1910, 1911 and 1912 there were 30-day periods during which B. coli were present in 1 c.c. of the Croton water from 21 to 28 days out of the 30. Where this bacterium is present in 1 c.c. or less and for 70 to 93% of the time for periods of 30 days' duration, the water is not considered of good sanitary quality.

It must be remembered that the question is not whether on the average the water is good, or whether on the average it compares favorably with the average of some other water, but whether there are times when it is polluted. It is easy to see that by taking averages, good water—water above standard—delivered at one time may be used to cover up the averages of polluted water delivered at another time.

In addition to the evidence above outlined with regard to the pollution of the Croton water, qualitative bacterial studies which have been made from time to time indicate that sewage organisms, other than the bacillus colon, have been present in the Croton supply.

Where the pollution of a watershed is obvious, as it is on the Croton, and the bacterial results are such as to indicate the effects of this pollution, as is shown from the analyses at 135th St. Gate House, but one conclusion can be drawn and that is that the water as delivered to the consumer is at times more or less polluted. This condition suggests a potential danger which is a serious menace to any community, particularly to one in which so large a population is supplied from a single source, as in the case of the Croton system. The Croton system serves a larger population than any other single unfiltered supply in the world, and the results of a badly infected water might be appalling.

It has been suggested, owing to the tankage system which is in vogue in New York, that filtered water may become infected in the house tanks, which are very generally used in certain sections of the city, and that the quality of the filtered water will deteriorate therein. This, it occurs to us, is not pertinent to the question of filtration. The pressures in the distribution system of Manhattan are admittedly insufficient, and the City of New York should do as other cities—furnish water at sufficient pressure to remove the necessity for house tanks on all buildings five stories or less in height.

Effect of Storage Reservoirs

It is generally recognized that the consumer of Croton water has one great safeguard against danger from infection, and that is the large storage reservoirs. It is a fact that pathogenic bacteria do not multiply in water under natural conditions. They live sometimes for many months, but in ever decreasing numbers. In storage reservoirs, as time elapses, the number undergoes a rapid initial decline, followed by the continued life of the more hardy individuals and terminating in the death of all. The value of long storage is thus evident.

Unfortunately the reservoirs in the Croton watershed were not designed primarily for the purpose of purification. The period of storage is dependent entirely upon the amount of stream inflow. Rainfall and runoff records show that in times of flood the storage in Croton Lake is only sufficient to provide for a retention of the water flowing therein for from ten to fifteen days. As the time required for the water to flow through the aqueduct from Croton Lake to New York may be measured in hours, the period of detention in times of flood is not sufficient to give security against the introduction of an infected water into the City of New York, provided infection exists on the watershed.

Typhoid Fever as an Index of Pollution

The death rate from typhoid fever is commonly taken as one index of the quality of a water-supply. The death rate from this cause in the Boroughs of Manhattan and The Bronx, which are the only ones supplied with Croton water, are low when compared with other cities in the United States, even those supplied with filtered water, and has been falling gradually for the past decade.

The conclusion might be drawn from this statement that there is no evidence of typhoid infection from the water-supply, and it must be admitted that there is no strong evidence that the water-supply is responsible for even an appreciable proportion of the typhoid in these Boroughs. In March, 1907, however, following an unusual and sudden rise in the bacterial count in the Croton water, the typhoid rate increased by about 40 per 100,000, and the increased rate continued through the months of March and April. The result of this spring rise in the typhoid fever death rate is noticeable in the annual death rate in Manhattan for 1907, which was 17, as compared with 15 in 1906 and 11 in 1908.

During this outbreak of typhoid fever, the cases were quite uniformly spread throughout the Borough of Manhattan. The section of The Bronx supplied with Kensico water was not affected, but in those portions which were supplied with Croton water the increase was noticeable. It is also particularly interesting to note that the rise of 1907 occurred in the early spring, at which season the death rate from typhoid fever in New York is normally low, and it may be remarked that a low typhoid death rate in the early spring is generally considered indicative of a good water-supply.

While the 1907 typhoid outbreak may be more clearly associated with the water-supply than other noticeable changes in the typhoid-fever death rate, yet in September, 1909, there was in Manhattan a marked rise in the death rate from this cause, following a marked increase in the bacterial count in the Croton water. Again, in August, 1910, there was an increase in typhoid following a sudden rise in the number of bacteria in the water, and this same phenomenon may be noted in July, 1911.

The typhoid-fever rise in 1907 occurred previous to the introduction of the chlorination plant which was started in July, 1909, but the table shows that hypochlorite has not always been effective in the treatment of the Croton supply.

The reduction in the number of bacteria is not sufficient to insure a safe water at all times, and while there is an apparent decrease in the number of bacteria since the installation of the chlorination plant the number of positive tests for sewage organisms has increased.

It must not be forgotten that local filtration of water in hotels and apartment houses, and the widespread use of bottled waters, may to some extent mask the true typhoid death rate which would occur if raw Croton water were substituted for the treated or bottled waters. The typhoid-fever death rate in Manhattan cannot account for all of the typhoid which might originate there, due to the large transient population which is employed in the Borough, but resides in other Boroughs or in the environs of New York City, to which the vital statistics of Manhattan do not apply.

While great stress is laid upon the typhoid-fever death rate as an index of the probable pollution of a water-supply, it should not be forgotten that the death rate from this cause is not the only one which is reduced by the introduction of pure water. Experience in many cities has shown that coincident with the substitution of a pure for a polluted water there has been, not only the reduction of the typhoid-fever death rate, but also in the number of deaths from pneumonia, pulmonary tuberculosis, cholera infantum, dysentery, and other causes, so that the total reduction in the number of deaths has usually been from two to three times greater than that indicated in the typhoid-fever death rate. We believe that it is safe to assume that there will be some reduction in the general death rate following the introduction of the Jerome Park filter plant, which, while not normally great, will be appreciable.

When all is said, however, the typhoid-fever statistics of New York indicate that the Croton water is a reasonably safe supply from the sanitary viewpoint, except possibly for short intervals, as indicated by the typhoid outbreak in 1907.

The True Meaning of the Low Typhoid Death Rate

The low typhoid-fever death rate, contrasted with the watershed conditions and the bacterial results obtained from the examination of the Croton water, should be regarded as suggestive of the absence heretofore of conditions on the watershed which have been contributory to appreciable typhoid infection. The low typhoid-fever death rate does not, under the circumstances, indicate that the Boroughs of Manhattan and The Bronx are not liable at any time to the danger of infection.

Experience on various watersheds, and under various conditions, has shown that the purchase of land in the form of sanitary strips along the water courses, the sanitary patrol of the watershed, the use of hypochlorite of lime, and the other means which have been adopted by the Water Department to safeguard the Croton water-supply are not sufficient and satisfactory at all times. This fact is illustrated in the case of the Croton watershed by the gradual and steady increase in the presence of sewage organisms, notwithstanding the precautions which have been taken to prevent pollution of the watershed.

Filtration is the most obvious, and as far as known the most economical effective means of protecting a community from the possibility of an epidemic outbreak as a result of an infected raw water, whether such infection be spasmodic or continuous.

The Commission next reviews the various processes of water purification. It points out that hypochlorite is better suited to the disinfection of filtered than unfiltered water. It also explains the use of lime or soda to remove the increase of free carbonic acid in water treated with sulphate of alumina, the free carbonic acid giving rise to corrosion of pipes, particularly service pipes.

The Commission shows the impracticability of filtering the Croton supply and the new Catskill supply at one plant, owing to a superelevation of 160 ft. in the Catskill supply. It then approves the location of the proposed mechanical filtration plant in the east basin of the Jerome Park reservoir and states that mechanical filtration will be less costly than slow-sand filtration. Existing mechanical filtration patents, it says, "do not offer a serious menace of litigation which will involve the city in subsequent appreciable cost." Royalties on filtration patents thus far have been small, and all the "more important patents will expire within a year or so after the earliest date at which the proposed Jerome Park filters can be completed." The filter design and specifications are approved by the commission.

Under the heading "Economic Considerations," the Commission states that its own estimates of the cost of the filter plant check within 6% of those made by the Department of Water Supply, which it believes to have been reasonable, especially in view of the close bidding. The commission estimates annual operating and capital charges at $800,000 in place of the department's estimate of $742,000. It also states that the "lowest bid is so advantageous" as to warrant its acceptance unless filtration is to be postponed three years, which would mean a postponement of filtered water for six years. It then adds:

The population and pollution on the Croton watershed are gradually increasing. . . . . There is not sufficient evidence at hand to state that the needs for filtration three years hence will be appreciably greater than they are today, and hence the question of immediate construction resolves itself into a balancing of cost against the immediate necessity for filtration.

It finds that the annual cost of filtration will amount to about ¾c. per $100 of assessed valuation, increasing the present rate from $1.83 to $1.83¾, since under New York conditions this cost will all go into the general tax levy. Against this cost there will be savings to those who now treat the Croton water-supply privately or buy bottled waters, but it adds that the latter practice may continue to some extent after filtered water is available. The report continues and concludes, as follows:

We further believe that a clear, bright and colorless water-supply is a business asset to any city, possibly not measurable in dollars and cents, but a very valuable asset nevertheless.

The question, therefore, is whether the immediate necessity for filtration is sufficient to warrant an increase in the tax rate of 0.72c. per $100 per annum.

We recommend that independent of filtration the Water Department shall in no way diminish the present sanitary patrol, or the precautions taken to lessen the pollution of the sources of water-supply, and that the Board of Estimate and Apportionment should supply extra funds to provide for more complete and thorough protection of the sources of supply.

We further recommend that the experiments which have recently been conducted with a view to improving the quality of the Croton supply by drawing water at lower depths at certain seasons of the year be continued.

We further recommend that experiments be conducted to determine the value of aëration of the water drawn from Croton Lake prior to its delivery to the filtration plant.

We are also of the opinion that it will be advantageous to aërate the waters drawn from the upper reservoirs prior to discharging them into the streams tributary to Croton Lake, but before installing such aëration works, we recommend that careful experiments be made by the Water Department to determine the effect of aëration at the upper reservoirs upon the quality of the water delivered to Croton Lake. The cost of aëration will not materially affect the cost estimates already submitted.

We recommend the more regular and systematic use of copper sulphate, not only in Croton Lake, but in the upper reservoirs. The cost for the regular and systematic use of copper sulphate will not be measurable.

As a result of a full consideration of the quality of the Croton water, the environment of its sources and the economic questions involved, and all other pertinent questions which have been treated in this report, it is the opinion of this Commission that the filtration of the Croton water-supply is not imperative, but that it is highly advisable to filter the water at this time both with a view to improving the physical quality and as a safeguard against potential danger, and we so recommend with the exception of one member dissenting.

NICHOLAS S. HILL, Jr., Chairman, Consulting Engineer;
JOHN H. GREGORY, Consulting Engineer;
E. P. GOODRICH, Consulting Engineer to the Borough President of Manhattan;
AMOS L. SCHAEFFER, Consulting Engineer to the Borough President of the Bronx.

I concur with the majority opinion except on those points which have led to the conclusion that filtration is needed at the present time. The minority opinion on the question of

the need of filtration is discussed more fully in the minority report which is transmitted under separate cover.

JOHN H. FRAZEE, Assistant Engineer, Department of Finance.

The Dissenting Report

As has been noted, Mr. Frazee agreed with the majority report except as to the immediate need of filtration. In his minority report he bases his dissent upon personal experience as to the palatability and appearance of the water, upon the low typhoid fever rates of Manhattan and the Bronx, and upon the belief that remedial measures in the Croton drainage area should precede filtration and would in themselves be sufficient for some time to come.

Mr. Frazee presents two tables of typhoid statistics to show that Manhattan and the Bronx have lower typhoid rates without filtration, but with chlorination, than the other cities in the state and most of those outside the state have with filtration or with filtration and chlorination combined. As to the Manhattan and Bronx typhoid rates, those declined from 11.4 per 100,000 in 1908 to 7.4 in 1912, and were 50% lower in the first quarter of 1913 than in the first quarter of 1912. Cleveland, with chlorination since February, 1912, had a typhoid rate of less than 6 per 100,000 for that year.

As to various remedial sanitary measures in the Croton drainage area, the Central Park reservoirs, etc., Mr. Frazee, for the most part, merely amplifies the statements and recommendations of the main report (to which in these respects he agreed) except that he urges these as at least a temporary substitute for filtration. He states that "some six or seven miles of steam railroads cross this watershed in five lines or branches," and that about three miles of these railroads cross the waters of the various reservoirs and some six miles skirt the reservoirs and tributary streams. Moreover, whereas at one time it was reported that the railroads "kept the closets in the cars locked" while passing through the Croton drainage area "no control over the discharge of fecal matter into the reservoirs has existed for some time past" and at present "not even drip pans are provided under bridges and trestles." He urges that the "sanitary patrol of the 360 sq.mi. of watershed furnishing the Croton supply consisting of 16 men, ranking largely as laborers, under a foreman, supervised by Water Department Engineers" be improved in amount and in character; that wash into the reservoir from an exposed dirt bank and from loose highway bridge floors be stopped, that reforestation work, shrub and grass planting be undertaken to screen off and otherwise reduce dirt carried into the reservoirs and that swamp waters high in color and organic content be cut out.

Mr. Frazee next proceeds to build up an argument under the heading "Financial Advantages of Delay." The first basis for this argument is that sanitary protective measures in the drainage area would reduce the quantity of chemicals required in mechanical filtration when such a plant was established. He says:

> The corrective measures proposed appear, then, along the line of ultimately procuring from a purer, raw water, a filtered effluent with less bacteria than otherwise to be had.
>
> Further, if it be assumed that the less the color and turbidity to be overcome, the less the extent of chemical treatment necessary, operating economies in the filters, when to be constructed, will ensue. . . . . If the proposed ameliorative work on the watershed improves conditions to the extent of even 20%, a proportionate saving of the $175,000 worth of coagulating chemicals to be required otherwise, should be affected, or $35,000 annually.

By postponing filtration, Mr. Frazee states, $800,000 a year would be saved in capital and operating charges, or $400,000 net after allowing for the cost of additional sanitary protection in the Croton drainage area. This would make a total of $2,000,000 for a five-year delay, besides which there would be a further saving of first cost and of possible litigation through the expiration, meanwhile, of various filtration patents; also a possible gain through "new methods of treatment of operation" devised in the interval. Large additional saving, Mr. Frazee estimates, would result from delays, due to the release of a large storage-reservoir area for sale on the introduction of the Catskill supply [but a large part, if not all, of this saving would be possible in any event, as we understand the conditions.—Ed.]

Mr. Frazee's conclusions and recommendations were that filtration can be indefinitely postponed by correcting the conditions which he outlined in his report; that there should be delay at least until land at the Jerome Park Reservoir can be released for sale; that funds should be provided for watershed improvements, for aëration, for Central Park reservoir and city main improvements; and that action should be taken against railway nuisances in the watershed and to control the sanitary conditions of house tanks. Some of these recommendations, it will be seen, are identical with those offered by the whole committee, regardless of whether or not a water filtration plant is built.*

Action by the Citizens' Union

Mention has been made of a Citizens' Union report, submitted to the Board of Estimate on May 8, 1913. This was signed by a committee of four, with Wm. Jay Schieffelin as chairman. It consisted chiefly of a summary of the majority and minority reports just abstracted with general and specific indorsement of Mr. Frazee's conclusions.

Two points credited by the committee to Major Cassius M. Gillette, of Philadelphia, were: (1) Mechanical filters would increase the hardness of the Croton water; (2) filtering the water-supply of Philadelphia, in the opinion of Major Gillette, has had no appreciable effect on the amount of water filtered at private expense or on the purchase of bottled water.

Two other points either originating with or indorsed by Major Gillette were: (1) That the contract bonds required under the proposed filtration contract ($1,000,000 during and for one year after construction and $150,-

*Mr. Frazee's minority report, we understand, was a surprise to the other four members of the Advisory Commission of Engineers, who had supposed during the deliberations of the Commission that Mr. Frazee would simply dissent as to the need for immediate filtration. The minority report, therefore, led to a supplementary report by the majority, in which they urged: (1) that Mr. Frazee's personal experience as a water consumer should be given little weight as against the consensus of expert and laymen opinion that at times the physical qualities of the Croton supply are highly objectionable; (2) that the majority's opinion as to the quality of the Croton water is based on samples taken above the Central Park reservoirs and (3) that these reservoirs are soon to be cut out from the regular service, so their effect on the water-supply may be ignored, so far as the need for filtration is concerned; (4) that the majority as well as the minority urges increased sanitary supervision in the Croton drainage area, but the majority is convinced that sanitary supervision alone, in the Croton or other watersheds, would be impracticable as a safeguard against pollution, and would be far more expensive than filtration; (5) that real estate sales at the Jerome Park reservoir site may be made regardless of which basin is used as a filtration site, but that Mr. Frazee's proposition calls for an unsafe reduction in the amount of raw-water storage at this place. A second supplementary report, in reply to the first one, was issued by Mr. Frazee. Neither of the supplementary reports, nor lengthy appendixes accompanying the majority report, nor the letter transmitting that report were printed, and only small editions of the majority and minority reports were printed.

000 for six years additional, the former for faithful performance and the latter to cover possible filter patent complications) are excessive; and (2) that "there are several uncertain and ambiguous provisions" in the specifications. Of these two are mentioned and commented on:

The indefinite specification relative to clay in item 8 sect. 8.2 may cost an unfavored contractor $50,000; and the indefinite provision relative to loam contained in item 7 sect. 7.2, $100,000 over the cost of materials which would fill the actual requirements of the city. An unnecessary discretion in the selection of materials is given to the engineer. Unless the prospective bidder received advance information as to what grade of material would be required by the engineer, he would have to figure on furnishing the most expensive material. Provisions where the engineer must use his discretion are common in this contract.

The courts have held that where indefinite provisions of this nature are contained in a contract a suit by a bidder to whom the contract was not awarded will lie against the city.

The exact wording of the two cited sections is:

Sec. 8. 2. The puddle shall consist of a mixture of plastic clay with broken stone, or sandy gravel, or both. In general the proportions shall be one part of clay to one part of stone and one part of sandy gravel, but the relative amounts of stone and sandy gravel may be changed by the Engineer so as to obtain the best mixture **taking into account the amount of suitable sandy gravel found in the excavations.** [Blackface type ours.—Ed.].

The clay shall be plastic clay of good quality, free from sand, loam, mica or other foreign matter.

The sandy gravel shall be of sound, durable material, all of which will pass through screens having 1-in. mesh, and shall be graded from fine to coarse. The broken stone shall be the same as that specified for Item 10.

. . . . . .

Sec. 7. 1. Under Item 7 the contractor shall prepare the surface to receive the loam surfacing, and shall furnish and place loam upon the filling over the reservoir arches, upon the embankments, and upon other graded areas, as ordered, after settlement has taken place, to the lines directed, with allowance for shrinkage. He shall fertilize and seed, and roll the finished surface. In general, **the depth of loam shall be 4 in., but a greater depth may be required on certain areas.** [Black face ours; the reader should understand that the loam is to be paid for by the cubic yard.—Ed.]

Sec. 7. 2. The loam shall be a mixture of clay loam and organic mold taken from cultivated fields showing satisfactory cultural results. It shall be fine, free from stones, roots and weeds and shall be alkaline. Samples shall be furnished for testing a sufficient time before shipping.

Another specification requirement copied in an "Exhibit" submitted with the report, but not commented on, gives the engineer authority to change the relative amounts of sand and ballast in concrete aggregate, "in order to produce the best results for the purpose intended," with no extra expense to the city; also authority to change the "proportion of cement in the mixture," but "all additional cement so required will be paid for."

Commissioner Thompson's Review

On May 9, Henry S. Thompson, Commissioner of Water Supply, sent a long letter to Mayor Gaynor answering the objections of the minority report and of the Citizens' Union. Among other things the letter states that both Mr. Frazee and the Citizens' Union took typhoid death rates "as the sole index of the quality of water," overlooking its effect upon other diseases and the general death rate; and they also based conclusions on water analysis averages for a long period. As to the latter, Mr. Thompson states that the analyses for the year 1907 show less pollution than for any year of the ten from 1903 to 1912, except 1908, "and yet in 1907 there was a typhoid epidemic caused by the pollution of the Croton water."

Records of analyses and complaints alike show the need for filtration. By far the great majority of the citizens are unable to filter their water-supply in their houses or to buy filtered water, and those, Mr. Thompson urges, are entitled to have a safe, palatable and good looking water supplied to them by the city—especially as the added cost of filtration will not be over 25c. per capita and the water-works yield a handsome revenue.

A significant point made by Mr. Thompson related to the sanitary protection work in the Croton drainage areas as a substitute for filtration. The city already "owns *about 21,000 acres of land, or about 8% of the entire watershed, and these lands have cost over $12,000,000, while the taxes thereon are over $100,000 annually.*" A marginal strip along all streams would require "some 40,000 acres at an estimated cost of $25,000,000," with $300,000 taxes and $1,000,000 interest yearly. It is estimated that the cultivated lands, roads, etc., which contribute silt to the streams total 70,000 acres or 30% of the watershed.

Another significant point made by Mr. Thompson in reply to the Citizens' Union is that the amount of the bond required for faithful performance of the proposed filter contract has no relation to the premium which the contractor must pay, since that is based on the amount of the contract. In the present case the premium would be $26,000 a year (0.5% on about $5,200,000).

Mr. Thompson also alleged that the clay and loam specifications "are those customary and which hitherto have been sufficient," and that the "mechanical filters, as ordinarily operated," will not "increase the total hardness of the water in the slightest degree." He adds that either milk of lime or of soda will be used "at intervals, if required, to reduce the carbonic acid which tends to corrode metal structures." Soda will absolutely prevent increase of hardness and if lime be used the increase "would be hardly noticeable, in fact, would scarcely be detected by consumers."

Late Additional Reports

In view of the questions raised as to the need for filtration, Allen Hazen was asked by Commissioner Thompson to make a statement on that subject. His reply is dated May 20, and is particularly significant in view of allegations which have been made by the Citizens' Union regarding his attitude towards the project. Lack of time and space prevent our giving more than a general idea of his report. He declares:

It is my opinion that it is necessary to filter Croton water. It is necessary to filter it because in no other way can a supply of clean water of good quality, worthy of the city, be secured.

Filtration will do more to improve the quality of the water and protect those who use it from infections resulting from pollutions upon the catchment area, than has been accomplished by all the measures of sanitary inspection and prevention of pollution of every kind that have been applied up to the present time, and that can be reasonably applied in future.

It is also necessary to improve the physical characteristics of the water to make it acceptable for drinking water by the people of this city.

Mr. Hazen refers to the growth of population in the Croton watershed and reviews the limitations of storage, of hypochlorite treatment, of sanitary inspection and land purchase as safeguards without filtration. He declares that the physical qualities of the water can be improved "so easily and at so small relative expense that

there is no excuse for continuing to use the water in its present raw state." He urges that the cost of filtration can be met from the surplus revenues of the water department, and that every city department should pay its own bills. [Surplus revenues of the water department are now used, it is reported, to reduce the general tax rate.—Ed.]

Another member of the consulting board of which Mr. Hazen was chairman, Geo. A. Johnson, of New York City, also reported to Commissioner Thompson on May 20 that in his opinion "it is necessary to filter the Croton supply as promptly as is practicable," on account of the frequent muddiness, continuous color and frequent offensive taste and odor. "All other means" than filtration, "such as forestation, sanitary patrolling, sedimentation, sterilization of the partially clarified water as it leaves the reservoirs, are insufficient and unsatisfactory and filtration is required."

Finally, there has been brought to our attention the testimony of Dr. E. J. Lederle, health commissioner of New York City, in favor of filtration for both health-protective and sanitary reasons. Dr. Lederle speaks with authority, not only because of his present and his previous official position as health commissioner, but also because of his long period of service as assistant chemist and later as chief chemist of the Department of Health, during which he made and supervised many chemical and bacterial examinations of the Croton water-supply, besides making sanitary inspections of the Croton drainage area.

Dr. Lederle quotes a telling sentence from Dr. Jacobi, "dean of the medical fraternity of New York City," who, on having been asked to serve on Dr. Lederle's Typhoid Committee wrote: "If you filter your Croton water and boil your milk you won't have any typhoid; it would be a waste of time my serving on your committee."

Convention of the National Fire Protection Association

The 17th annual meeting of the National Fire Protection Association was held in the convention hall of the Metropolitan Life Insurance Co., New York City, May 13, 14 and 15. All the sessions of the meeting were given up to discussions of the Association's fire-prevention work; there were no entertainments. The first session disposed of the usual formal business and immediately proceeded to its heavier program. The address of the President, H. L. Phillips, of Hartford, Conn., was a plea for a broadening of the Association's field of activities and of membership. The secretary's report gave a brief account of the speaking tours made, to spread the doctrine of fire prevention, under the auspices of the Credit Men's Association and the American Institute of Architects. At the end of the convention the following officers were elected: President, R. D. Kohn, of New York; Vice-President, F. M. Drake, of Louisville, Ky. F. H. Wentworth, of Boston, was reëlected secretary and treasurer.

The work of this association is presented by committee reports of the year's activity rather than through individual papers. There were, however, two addresses, one by Miss Frances Perkins, Secretary of the New York Committee on Safety, and the other by D. Knickerbacker Boyd, Chairman of the Committee on Public Information of the American Institute of Architects. The first address was largely occupied by a description of the varied losses which the city of New York suffered as a result of the disastrous Triangle-factory fire in which 145 young women, factory operatives, lost their lives.* Investigations carried on since this fire to eliminate conditions which threatened to cause a similar loss of life were outlined. Mr. Boyd's address was a review of the possibilities which existed for educational work by coöperation between the National Fire Protection Association and other bodies; his ideas were illustrated from the experience of the American Institute of Architects, under whose auspices the Secretary of the National Fire Protection Association had made a tour of the country addressing chapters of the Institute on fire-protection equipment and methods.

Reports on Fireproof Construction—The Committee on Fireproof Construction (Ira H. Woolson, of New York, chairman) presented a report which was hailed as the first advance in defining standards of true fireproof building construction. The report fixed the general specifications for a so called standard building which would be truly fireproof with the most hazardous character of contents. The four general requirements for a building of this class were stated as follows:

> (1) All material entering into its construction shall be incombustible and all structural parts shall resist fire for at least four hours at an average temperature of 2000° F. without severe damage.
>
> (2) Ample and safe means of egress shall be provided for all occupants.
>
> (3) The building shall be so constructed that a fire will be confined to the area in which it originates, and the building will be protected against exterior fire by approved doors and windows, etc.
>
> (4) The building will be equipped with such apparatus that a fire can be extinguished in it in incipient stage.

Reinforced-concrete played a large part in the design of such a building according to the specifications presented. Some of the restrictions, such as the size and location of wall openings, were objected to by some of the architects in attendance, but after a long discussion of such details it was finally settled by regarding the proposed specifications as for a building with the most hazardous occupants in all respects and noting that a permanent decrease in some hazards migh permit deviation from the restrictions imposed.

The Committee on Safes and Vaults (H. W. Forster, of Philadelphia, chairman) presented some tentative specifications for the construction of large and small vaults of the better class. The chairman in presenting the report stated that since the specifications had been printed, the committee has continued its investigations and as a result they were prepared to recede somewhat from the rigid standards therein proposed. For instance, the specifications considered only fireproof qualities and the committee admitted that it was not possible to consider fireproof qualities without also considering at the same time the burglarproof construction, which increased fireproof qualities. The committee desired authority to present revised specifications to the executive committee for adoption and promulgation, but there was some objection to this procedure, in view of the lack of necessity for hasty action on specifications for this construction.

*See "Engineering News," Mar. 30, 1911, pp. 387 and 396; Apr. 6, 1911, p. 420; Apr. 13, 1911, pp. 458 and 464; Apr. 20, 1911, p. 493.

MODEL LAWS AND ORDINANCES—The report of the Committee on Laws and Ordinances was perhaps the most thoroughly discussed of all. There were presented a number of model ordinances to be recommended for villages and small towns, together with a suggested ordinance to regulate the use, handling, storage and sale of inflammable liquids and products. The list of the short ordinances comprised (1) one providing for regulation of the installation and operation of all devices and equipment for the generation, transmission and utilization of electric current; (2) one providing for the cleanliness of streets, alleys and premises; (3) regulating equipment and operation of picture machines and premises; (4) regulating automobile garages; (5) regulating the equipment, use and maintenance of heating apparatus; (6) regulating the manner of connecting gas heating devices, etc.; (7) prohibiting the discharge of fireworks; (8) prohibiting the erection of tile, terra-cotta, cement-block, brick-on-edge or metal flues; (9) regulating the burning of refuse; (10) regulating the storage of explosives; (11) two providing for fire limits and the construction of buildings, one originating with the National Board of Fire Underwriters and the other with the Kentucky Fire Prevention Association; (12) one regulating the use of fire-protection equipment, and (13) one providing for fire escapes.

The first important bone of contention was an item relating to automobile garages. The model ordinance contained a prohibition of flames of any sort (lamps, pilots, etc.) on motor cars inside garages, and the sponsors urged that the association should include this as a protest against a very unsafe practice. The objectors, however, held that it had been found utterly unenforcible and that the evil of enacting legislation admittedly unenforcible was worse than the trouble attacked. The prohibition was struck out. Objection was made also to having two ordinances on city fire limits and building construction, and the two were referred back for consolidation. It was reported by the committee also that it proposed to consolidate all the ordinances on related subjects into a code for small cities where there was no power to enforce detailed supervision of building construction.

About half the report was given up to a suggested complete ordinance to regulate the use, handling, storage and sale of inflammable liquids, etc. It was explained that this was the completed work of several former committees and that the ordinance was very much desired throughout the country. Inflammable liquids were classified in accordance with their flash point. Class 1, which was regarded as the most dangerous, comprised ether, carbon bisulphide, gasoline, naphtha, benzole, collodion, "hydro-carbon" (gas drips) and liquified petroleum gas. The least dangerous (Class 3) comprised kerosene, amyl alcohol, turpentine, whisky and brandy. Intermediate between these two were acetone, alcohol, amyl acetate and toluol, comprised in Class 2. Severe restrictions were placed on the storage of Class 1 and Class 2, although in a few minor ways Class 2 was to be treated like Class 3. Strong and long-continued objection to this classification on the basis of flash point alone was raised by men interested in the manufacture and sale of alcohol for commercial use. It was claimed that the actual fire hazard was not in proportion to the flash point, which placed alcohol in Class 1, but that it was greatly reduced through the lightness of alcohol vapor and its rapid diffusion in air to a noninflammable and nonexplosive mixture, together with its miscibility which prevented the burning and vaporizing liquid from being scattered by water. This ordinance was not adopted by the meeting, but was referred as a whole to the executive committee of the association with authority to continue the study of the disputed points and with power to promulgate such an ordinance as was deemed advisable without waiting for its submission to the next annual convention.

Closely related to the preceding report was one by the Committee on Uniform Test Specifications for Determining Flash Points of Oils (Irving C. Allen, of Pittsburgh, chairman). The committee announced that it had adopted as its report technical paper No. 49 of the U. S. Bureau of Mines, which represented studies made under the direction of the chairman by this Bureau.

FIRE-PROTECTION EQUIPMENT—The first report on automobile fire-fighting apparatus was brought in by the committee on that subject (George W. Booth, of New York, chairman). This described the present lines of new apparatus and the reconstruction of older horse-drawn vehicles. The committee believed that the use of a tractor, as a substitute for the front wheels of old fire apparatus, has a permanent and useful function. The committee stated that the triple-combination wagon which was being put out, having some of the equipment of chemical-extinguisher wagons. pumping engines and hose carts, could not be recommended for general adoption inasmuch as (1) it put too much apparatus out of service in case of accident to one vehicle and (2) valuable time was lost in putting the machine into service as a pumping engine after it was first tried as a chemical wagon. It was believed that the craze for speeds of 60 miles an hour was disappearing and that the limit now found desirable was 30 miles. The committee reported that the general saving in annual cost of automobile over horse-drawn apparatus was not remarkable in most cases, interest and depreciation charges being large factors of expense. The reported savings in 20 cities ran from 20 to 40%, the lower figure applying to engines and the higher to ladder trucks. The cost of fuel has been found to be about $5 per hour for the steamers and $2.50 per hour for the gasoline-driven pumps.

The Committee on Fire Pumps (H. O. Lacount, of Boston, chairman) made a brief report in which they brought in some revisions in the specifications for steam-pump stuffing boxes, and recommended the horizontal parting of the casings of centrifugal pumps.

The Committee on Hydrants and Valves (H. O. Lacount, of Boston, chairman) had found that available hydrants for mill yards were in need of redesigning and after conference with manufacturers, it had drawn up new specifications for these hydrants. They were designated as two-way, three-way, etc., according to the number of 2½-in. hose outlets. The specifications, in general, provided for greater clearances and free waterways.

The Committee on Standard Hose Couplings and Hydrant Fittings for Public Service (S. M. Griswold, of New York, chairman) reported on the continuance of its efforts to have standard hose fittings adopted by the whole country. It was reported that there were now 54% of the total municipalities using standard fittings or those adaptable to standard.

The Committee on Gravity Tanks (Gorham Dana, of Boston, chairman) brought in some general specifications

for concrete reservoirs, valve pits and tanks, which it was intended should be in addition to the present printed requirements on tanks, replacing some insufficient and inadequate sections thereof.

The Committee on Automatic Sprinklers (E. P. Boone, of New York, chairman) brought in a number of additions and improvements to the existing specifications for this type of fire-fighting apparatus. These points had to do largely with the installation of sprinklers.

The Committee on Signaling Systems (Ralph Sweetland, of Boston, chairman) brought in some additions to the rules and requirements for the construction and use of signaling systems. These related principally to suggestions for protection against lighting and the use of thermostats.

TESTS OF PROTECTIVE EQUIPMENT—The Committee on Field Practice (C. H. Patten, of Cleveland, Ohio, chairman) presented the advance sheets of a pamphlet entitled "Field Practice Manual of Fire Protection, Inspection and Tests for Use of Inspectors, Laymen, Factory Superintendents and Fire Department Inspection Corps." The committee had arranged specific and detailed instructions, intelligible to all those named in the title, covering the more essential features to which special attention needed to be given in order that the efficiency of protective installations should be continually kept up. The pamphlet was presented to the members for their study and at the committee's request was held over for one year to be adopted at the next convention with an added section on inspection for fire hazards. However, on account of the demand for such a manual, it was voted to reprint the instructions (with an added section on hazards) for distribution as advance information.

SPECIAL FIRE HAZARDS—The Committee on Explosives and Combustibles (C. A. Herkimer, of Philadelphia, chairman) continued its work of outlining the rules and requirements for fields of extreme hazard. This report took up the subjects of (1) construction and installation of gas shutoff valves outside buildings; (2) rules for the storage and use of fuel oils and oil-burning equipment, from the largest to the smallest installation; (3) the construction and installation of dip tanks for lacquers, etc.

The Electrical Committee (F. E. Cabot, of Boston, chairman) reported that it had completed and adopted a general revision of the so called National Electrical Code by rewording certain technical phrases which removed the few legal obstacles which had been encountered by various municipalities in adopting the provisions of the code for their building requirements. There were also some advances in the rules for rubber-covered wire, armored cable, and conduit. Perhaps the most important change was in making the grounding of alternating-current secondary circuits mandatory. This step was taken for the greater protection of life by removing the possibility of chance high potentials on low-voltage service lines.

The Committee on Blower Systems for Heating, Ventilating and Stock Conveying (A. Blauvelt, of Chicago, chairman) presented the unique statement that there was little that the committee could do further in the discussion of this subject or the improvement of existing conditions, and recommended that the committee be terminated. A short report was presented which briefly summed up the uses of this sort of apparatus, with the recommendation that while it was practically impossible to have a positive cutoff for fire between compartments connected by blower flues, yet the use of automatic sprinklers, automatic dampers and signals should be installed as the greatest approach to safety that could be arranged.

The Committee on Manufacturing Risks and Special Hazards (Benjamin Richards, of Boston, chairman) continued its work of studying the elimination of hazards in various special fields by reporting this year a pamphlet on the improvement of shoe factories. These brochures are merely of informational character, being sent out widely to all interested, as an effort to reduce the fire losses in these special fields.

PROGRESS REPORTS—"General progress" was reported by Committees on Standards, Forest Fires, Mine Fires, Coverings for Window and Door Openings, Controlling Equipment for Electric Pumps, Hose for Hazardous Fluids, Private Fire Supplies from Public Water Mains, etc.

Investigation of Prospective Hydroelectric Power Service for Reliability

BY H. S. KNOWLTON*

The investigation of possible markets for power, in territory contiguous to water power which seems open to advantageous development, is a familiar phase of the preliminary work on hydroelectric projects. The common implication is that a prospective customer will jump at the chance to get cheaper power, provided the rates and representations of the new concern are satisfactory.

However, there is another side to the same question—the need of careful scrutiny by the prospective customer of the service which the power company can undoubtedly furnish.

Few problems are of greater interest or of more technical difficulty than the investigation on the part of the industrial plant owner or his representatives, of the reliability of the proposed service. In some communities transmitted water power has been in use long enough to establish the reputation of its distributors for supplying energy continuously and at good voltage regulation over very extended periods. In other cases, interruptions are frequent and fluctuations in electrical pressure severe; breakdowns in lines; shortage or excess of water at the wheels are troublesome; and operating conditions on the transmission system anything but stable. Finally, the manufacturer, seeking a cheap supply of reliable energy, may have to face the question of deciding how far it will pay to trust his requirements to the possibilities of a new or partially completed transmission and distribution system offering power, it is true, at low and attractive rates but, to some degree at least, uncertain as to the quality of service from month to month in season and out.

The solution of such problems is primarily a task for the consulting engineer, or at least is a process calling for the exercise of no small amount of technical as well as commercial ability. The fact that the economy of the proposed service at the rates offered has been demonstrated, does not for a moment free the prospective purchaser from investigating the reliability of the supply which he is likely to receive. In the administration of

*23 Richardson St., Newton, Mass.

large industrial establishments, whose daily fixed and operating costs are maintained on a great scale, something more than a fair certainty of good service must be considered even if the proffered contract contains stiff penalties for interruptions or allowances for bad regulation. In many such cases, the value of a rebate for lost service cannot adequately express the damage done by a prolonged shut-down; the necessity of continuous production transcends the benefits of any probable award by the courts to the consumer whose service has been defaulted. The reliability of electrical service everywhere in general has no great weight in such cases and the standards of hard-headed business acumen are the ones upon which the decision to buy or not to buy must be based. The rise of successful transmission systems, and their steady growth in acceptability throughout great areas economically tributary to their generating stations, is evidence enough that the exacting requirements of modern industry are, *in numerous instances,* being splendidly met by purveyors of hydroelectric power. But this foundation of general engineering achievement can support no project not found dependable after rigorous investigation of every important detail of its material quality; it permits no haphazard acceptance of prospectus data.

The importance of this question makes it desirable that the general method of attacking it shall be familiar to the industrial executive, even though he have the benefit of the best engineering advice. Any failure in the regular course of shop output due to insufficient earlier consideration of power requirements exacts a heavy toll if it occurs during a time when men and machines are being forced to meet rush orders upon which the reputation of the establishment depends. Contingencies must be anticipated and time devoted to the study of the hydroelectric power company's resources, including a minute study of the reports of engineering advisers, is well spent by the industrial executive who would limit the uncertainties which surround his business, to the smallest possible amount.

To illustrate the important factors in an investigation of service reliability, the writer will outline the procedure in a recent instance, where a manufacturing community was considering the wisdom of purchasing power derived from two interconnected hydroelectric systems under a common control. The investigation chiefly concerned the probable character of service which the hydroelectric companies could give and whether the manufacturers would benefit by competition between the former and a well-established central station. It appeared at the outset that, aside from the question of intelligent management, the character of the service would depend largely upon (1) the design and equipment of the power stations and transmission lines (2) the condition of the water-supply and (3) the character and amount of the load carried. Investigation soon showed that the plants and lines in operation and under construction were well-designed and apparently represented the best modern practice. This point having been determined by competent engineering inspection, the important question of generating capacity came up.

An examination was made of the number and rating of generating units in each station and, following the tabulation of these, a careful study of existing stream gagings available among the data of the U. S. Geological Survey. The point was brought out that the average output of the main generating station of the older of the two hydroelectric systems must be far below its rated capacity on account of the large fluctuations in the river discharge. A further disadvantage was emphasized in that the reservoir capacity above the dam at this station was only sufficient to store approximately the normal 12-hr. flow of the stream. At times also, the river flow was found to be almost negligible, so that under extreme low-water conditions only a small load could be carried by the station. High water was likewise a drawback. On one occasion during the investigation, when the water was high on account of spring floods although not at its highest, this plant was observed to generate only 35% of its rated capacity. At that time, the turbines were not up to normal speed, the frequency ranging about 3½% below normal.

This question of frequency is one of the most vitally important in the operation of a transmission and distribution network by alternating-current, and its influence upon production is so well recognized that the best managed transmission systems provide automatic alarms at their operating headquarters for the warning of load dispatchers in case abnormal values are attained. In such networks, much larger percentage changes in voltage may safely be permitted than can be allowed in the frequency, which bears so directly upon the speed of motors in plants served by the system. In any study of service reliability, therefore, ample observations of this factor are essential.

It was also shown that any plan for the increased storage of water in the river basin above this plant was of doubtful practicability on account of the many interests involved and the necessity for enormous storage to serve the various installations on the stream at the relatively low heads employed.

A similar examination was made of the flowage of the river upon which the second group of generating units was located, the Geological Survey reports showing the stream to be extremely variable or "flashy" in its characteristics. Large storage reservoirs were seen to be absolutely necessary to realize anything like approximately continuous and steady service. The development plans of the company included such reservoir construction with necessary dams capable of storing a total of about six billion cubic feet of water, and it appeared that if the complete project of utilizing the entire available fall of the river should be carried out, an average development equal to 48,000 kw., or the rated capacity of the generating stations, could be secured for 3600 hours per year, permitting 10-hr. runs and delivering 170,000,000 kw.-hr. per annum. There was some question whether, considering the requirements of vegetation and natural evaporation, the full capacity of one of the large reservoirs could be attained in a dry year, but on this system the existence of various steam auxiliaries at certain industrial plants formerly operated by mechanical power or steam-produced electricity was a factor in guaranteeing a reasonably reliable service.

The projected reservoirs were the key to the whole power situation. Without them the plants on the two rivers, even though interconnected for supplementary operation, could not give a normal service without serious difficulty and expense. With these storage facilities, the desirability of the power was readily established.

The plants were located as a rule from 150 to 200 miles from the market in question, and figures covering the total cost of construction for the entire project gave about $12,000,000 as the investment necessary to complete the developments. The engineers who investigated the situation estimated that the company could afford to deliver energy at the proposed market at about 1c. per kw.-hr. Operating expenses for the generating system were figured at $400,000 per year, fixed charges being estimated at $900,000. This made the cost of energy exceedingly attractive, and a high degree of reliability was further assured by the transmission-line arrangements proposed, which included a double-loop system connecting practically all the generating stations and large users of power.

Regarding the question of competition between the hydroelectric organization and the local central station company, the opinion from the manufacturers' viewpoint was that if the latter should establish a tide-water plant equipped with very high-powered turbines, it could probably afford to sell energy at as low a price as the transmission concern.

It is, perhaps, not generally realized that with the larger sizes of steam turbines, electric energy can be developed at a labor cost of not far from ¼ mill per kw.-hr. in the boiler-room and coal handling plant, with switch board work and supervision by the chief engineer. This is assuming a 20,000-kw.-unit run at full load say 20 hr. per day, with a 25% overload for four hours. Careful preliminary analyses of station costs to be expected, as very large plants of this sort develop, indicate that power can probably be placed upon the busbars of the generating station at from ⅓ to ¼c per kw.-hr., even with coal at $4 per ton. This means that a very large central station, and particularly one having a substantial power load during the daylight hours, can compete closely with transmitted water power, even when all the charges are taken into account.

In the case under investigation, the potential purchasers of service have a choice, speaking in a broad way, between two independent interests. The shorter distribution lines of the local company favor the latter on the score of service reliability, for a transmission system, covering many miles of country and running from county to county, is inevitably subject to hazards unknown in the administration of lower potential systems, many of whose lines may be located underground with increased safety and continuity of operation. This phase of the case selected is incidental to the main line of inquiry taken by the writer but, in passing, it may be noted that one opinion widely accepted is that the whole situation will be strengthened by a co-operative agreement between the two organizations. Under this the central station will attend to the local sale and distribution of the transmission company's energy (with the interchange of energy or not according to engineering and operating considerations beyond the scope of this article).

Summing up the points noted above, it appears (1) that the investigation of service reliability in hydroelectric systems is an engineering problem, but one with a decided commercial twist, (2) that it involves the determination of hydraulic capacities and quality of speed regulation, (3) that it includes the study of any available records of interruptions and their causes, (4) the scrutiny of the quality of old plants and systems, (5) the new designs and construction, (6) the consideration of need for duplicate and looped lines, (7) the auxiliary sources of power, (8) the existing costs of production and the reasonableness of the rates offered and (9) the standing of the concern as a business enterprise. More and more must the large consumer of power investigate the outside seller of such service with something like the thoroughness with which the purchaser of its securities requires a certificate of good business health.

In the case cited, it appeared that a single engineering feature was the cornerstone of the whole enterprise, so far as the reliability of future hydroelectric service on a normal scale was concerned. In other instances, it will be found that the presence or absence of an adequate operating organization, the provision of duplicate lines or some other similar element will be sufficient to turn the scale for or against the proposed service under the conditions then prevailing. Reliability is coming to be a more important industrial question than the mere contract price of service. Yet even an unreliable service may have a place of great value in specific instances under the name of secondary or casual power. The investigation of hydroelectric service in no sense implies that its general reputation is unfavorable. It is simply a precaution which increasing costs of doing business render desirable; it is only another case where a prudent executive would not offhand contract for the purchase of important supplies on receipt of a low quotation.

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The Government and Public Works of Delhi, India*

By Tom Salkield†

Delhi is a first-class municipality possessed of important powers for local self-government, which have always been exercised in a satisfactory manner for the benefit of the 250,000 inhabitants.

The municipality consists of 24 members, of whom 12 are elected and 12 nominated by the deputy commissioner. In order that the interests of the different communities may be safeguarded, the representation consists of 8 Europeans, 10 Hindus, and 6 Mohammedans.

The deputy commissioner is ex-officio president of the municipality, and is supported by two vice-presidents, one a Hindu and the other a Mohammedan.

All the important work of the municipality is first dealt with by small committees, who present their reports to the full body of members, a meeting of which is held weekly.

The city is divided into 15 wards, and each ward member is vested with minor powers, and has much influence in the final disposal of matters relating to his ward.

WATER-WORKS

The city possesses excellent water-works. The source of supply is the River Jumna.

The works were inaugurated in the year 1890, when the sole source of supply was from a chain of 84 infiltration wells sunk along the bank of the River Jumna, which were calculated to yield 1,750,000 [Imp.] gal. in 16 hours; but from the start there was trouble, as sand was drawn into them, and by the year 1893 the supply of water had considerably diminished. A second series of infiltration wells, 60 in number, was constructed; but in the year 1896 the yield had dropped to 611,000 gal. in 16 hours, and was so insufficient that direct pumping from the river had to be resorted to, when sedimentation tanks and sand filter beds were established. These infiltration wells are no longer used as a source of direct supply, but have recently been put to a use not originally intended. When the river is in flood during the monsoon period it carries a large quantity of silt in suspension, which gave much trouble by scoring the pump-rods and clogging up the filter-beds, but owing to the head of water in the river at such times, the infiltration wells

*Slightly condensed from the "Journal of the Royal Sanitary Institute" (London) for November, 1912.

†Engineer to the city of Delhi, India.

stand full of clear water, and from them water is drawn and passed through the filter-beds.

The head works have been further enlarged to provide an adequate supply of water for the recent great Durbar. The works are not finished, but on completion will consist of the following:

INTAKE.—There are three Worthington horizontal triple expansion multiple pumps, any two of which can be coupled together. Each pump is 13 i.hp, and capable of raising 80,000 gal. an hour through two 14-in. rising mains to the sedimentation tanks against a head of 32 ft., including suction and loss by friction.

MAIN PLANT—There are two Worthington horizontal triple expansion multiple pumps, each 90 i.hp., capable of lifting 108,000 gal. an hour; one Worthington horizontal triple expansion multiple high-duty pump capable of lifting 160,000 gal. an hour is now being installed. In each case the pump lifts water through either an 18- or 20-in. rising main 6100 ft. long to the service reservoir on the Ridge against a head of 155 ft., including suction and loss by friction.

The service reservoir has a capacity of 2,500,000 gal. The settling tanks are two in number, and each is divided into three compartments.

The original filter beds were six in number, each 113x80 ft., but the number is now being increased, and on completion will consist, in addition to the original six, of six filters, each 170x100 ft. Also there is one 17-ft. diameter Jewel filter, capable of dealing with 500,000 gal. in 24 hours. The consumption of water during the year 1911 was 10 gal. [12 U. S. gal.] per head per day.

The filters were designed to filter at the rate of 40 gal. per sq.ft. per 24 hours [about 2,100,000 U. S. gal. per acre], but prior to the extension of the plant, they had to be worked at a much higher rate.

To enable the settling tanks and filters to work continuously, a clear water reservoir has recently been constructed to collect the filtered water during the hours when the main engines are not working. This reservoir is divided into two compartments, each capable of holding 600,000 gal.

From time to time, samples of water are taken for analysis and the results have always been satisfactory.

The supply, in common with similar works in India, which draw water from a river, is liable to pollution from several sources, the most serious at Delhi being: (1) the placing of dead bodies in the river; (2) the washing of clothes near the intake; (3) the proximity of the villages Chandrawal and Wazirabad on the west bank of the river about ½ mile and 2½ miles respectively from the intake; (4) the Najafgarh Canal which, I have no doubt, receives drainage along its course and which discharges into the river about 2½ miles above the intake.

It is of interest to record that throughout the city a gratuitous supply of filtered water is given by means of standposts. This has had a wonderful effect upon the health of the community, as diseases such as cholera, enteric fever and Delhi boils have ceased to be endemic.

Great waste of water, unfortunately, occurs at every standpost, owing to carelessness and improper usage. The Delhi inhabitant, in common with mankind generally, fails to appreciate blessings easily obtained.

Wells have been used for supply from time immemorial, and have been brought to a high state of efficiency in India, and to this day, although there is an adequate and cheap supply of pure water from the municipal mains, a large number of people prefer to obtain water for drinking purposes from certain wells which have a high reputation. In the hot weather the water from these wells is cold, which, perhaps, is the chief cause of their popularity.

Religious susceptibilities were at first responsible for a temporary boycott of the municipal water-supply; but as soon as the advantages were realized prejudices ceased to exist, and the acceptance of the municipal supply is now so general that large extensions of the works are necessary. The chief religious prejudices were that low caste people obtained their water from public standposts, and that leather washers* were inserted in private taps.

DRAINAGE

When the present city was designed by the Moghal Emperor Shah Jahan some time between the years 1635 and 1650, he provided a system of underground sewers, which were constructed of stone masonry, some with flat stone beds and others without any bed.

Many of these old sewers have, within recent years, been re-inverted, put into proper repair, and used as stormwater sewers.

So accurately were they laid that in many places the new system follows along the old alignments and with similar gradients.

*The fact that the cow is a sacred animal in India may explain this particular prejudice.—Ed.

In connection with the fortifications of the city, and as a further means of defence, walls were built, and a deep moat encircled them outside. Into this moat each old sewer emptied its quota of sullage water. This moat was, about the year 1898, converted into an open intercepting sewer. The invert, designed to take the dry-weather flow, is in brickwork of semi-circular section, and the benchings and the side retaining walls of stone.

This open sewer has a gradient of 1 in 500, and discharges sullage water onto a large tract of land about 1¼ miles outside the south gate of the city, on which area crops, chiefly sugar cane, are grown.

In consequence of the rapidly growing importance of all land outside the city walls, and with the ultimate object of constructing a circular road around the city, outside the walls, the open intercepting sewer is now being arched over, and on the site thus made available it is hoped that the proposed road will be constructed and bordered with a continuous garden, which will add much to the beauty and sanitary amenities of the city.

In every street on which houses exist open side drains have been constructed to convey sullage water into the underground sewers, and thence into the large intercepting sewer which encircles the city wall.

Up to the year 1906 no serious attempt had been made to carry out the proper drainage of the city, although schemes had been prepared for the undertakings. At that time in almost every road of the third and fourth class, as defined under my note on roads, sullage water meandered along the sides or down the center. If the liquid was of sufficient volume it ultimately found an escape into an old sewer, but generally it was either absorbed into the earth or evaporated by the sun. This state of affairs no longer exists. Many streets in the city and suburbs took their name from their filthy surroundings, such as "ganda nalas," meaning dirty water-channels.

The levels of the city and all suburban areas, except one, allow the sullage water in the sewers to gravitate into the intercepting sewer without any intermediate lifting. The suburb where pumping is necessary is a small one, for which a plant consisting of a pump well, two 12 b.hp. Hornsby oil engines, and two 6-in. low-lift centrifugal pumps are now being installed. Each pump is capable of delivering 400 gal. per min. through an 8-in. rising main against a total head of 38 ft., including friction and suction.

The system of drains and sewers is designed for dealing with liquids only, and this of course makes the sanitation of Delhi a very difficult problem, as, in addition to the daily cleaning of 150 miles of open drains, the annual disposal of 1,250,000 cu.ft. of dry refuse, and upwards of 2,000,000 cu.ft. of domestic refuse and nightsoil is a big undertaking.

REFUSE COLLECTION AND DISPOSAL

The bulk of the clean dry refuse is disposed of to brick burners, but it is of low calorific value. The nightsoil is trenched. The trenching grounds are about two miles outside the city, and for this purpose 250 acres of land are required.

After trenching any area one year is allowed to elapse before such land is put under cultivation, and after six years of cultivation the area is again trenched. About 40 acres of fresh land per annum are required for trenching.

As the habits of Eastern people are frequently so different from those residing in the West, the lot of the English sanitary officer in most of the larger cities of India is a constant succession of disappointments, as all working under him have had no Western training in sanitary science.

Complaints are frequently made by wealthy Indians of dirty surroundings, but many of these people forget that cleanliness, like the proverbial charity, should begin at home.

One of the most extraordinary survivals of the old days is what is known in Delhi as "birat," the hereditary right of a family of Mehtars or sweepers to remove filth and rubbish from a number of private houses, for which they receive payment in kind (food and clothes) as well as cash.

The sweeper or Mehtar caste in the larger cities of India is rapidly decreasing in numbers, not through lack of virility, but in consequence of the spread of education and the efforts of the various missions, who secure low-caste people and raise their status much more easily than is possible with the higher castes.

As this caste alone will undertake scavenging work the problem of sanitation becomes yearly more and more difficult. The sweeper, knowing his value, has banded himself into a most powerful Trade Union, by means of which he is able to intimidate not only his hereditary employer, but also the municipality. He has learned that with British-made laws he can work or play as he thinks fit, and consequently the comfort, health, and even the lives of the people are to a very large extent at his mercy.

All solid refuse matter is received at depots known as a "Dalaos," from the Urdu word "Dalna," to deposit, and from such places it is taken by bullock-drawn carts to trenching grounds outside the city, which are cultivated in rotation.

This system leaves much to be desired, and, although to the land is returned that which comes from it, the cycle stands condemned when dealing with large communities.

Palliatives have been tried. I wanted to introduce a system of hoppers which obviated all handling of the refuse, but it was never seriously taken up. Mechanical traction for quickly removing the refuse matter from the city is now being considered, but the only solution will be the provision of a water-borne system of sewage disposal and the erectoin of refuse destructor.

Until these are introduced and the people have been educated to understand that the streets are not dumping grounds for refuse, and the open drains not elongated receptables for filth, the sanitation of Delhi will not be as perfect as the authorities desire it to be. The sanitary superintendent has a thankless task in keeping together his wayward and undisciplined battalion 1000 strong of city sweepers and bhishties.

STREETS AND ROADS

The roads inside the city may be summarized as follows: 1st class, 10.2 miles; 2nd class, 4.25; 3rd class, 11.2; 4th class, 40.4. Total, 66.05 miles.* The total length of roads in the Civil Station and the roads connecting the city with the suburbs (all first class roads) is 29.57 miles. The suburban roads are as follows: 1st class, 7.58 miles; 2nd class, .74; 3rd and 4th class, 24.4. Total, 32.72 miles. The grand total of roads is 128.34 miles.

The roads of the first three classes are constructed of either limestone, known as "Kunkar," or the local ridge stone, broken to proper size and known as "Rori."

The important roads are lighted by electricity, and a complete system of electric tramways traverses the city and links up the distant suburbs.

GENERAL FEATURES

Delhi is well provided with gardens, which, apart from their charm, form excellent lungs. They are owned by the municipality, and are in the charge of an English superintendent of gardens.

The Municipal Central Hospital is a large and important institution.

The work of medical relief is very extensive, as municipal dispensaries exist in many parts of the city.

A veterinary municipal hospital has recently been erected, where much excellent work has been done to relieve the sufferings of all kinds of domestic animals.

The slaughter-house, vegetable market and minor markets are under municipal control. With the rapid growth of the population and the increasing importance of the city, additional and more extensive markets must be provided, and the existing markets will have to be reconstructed on improved lines.

The municipality possesses much valuable land and many properties, including the central police stations and all other police substations throughout the city, fifteen in number.

As a safeguard against destructive fires, two of Messrs. Merryweather and Co.'s engines have recently been purchased and housed in a new central fire brigade station, in connection with which quarters for the engineers and the brigade have also been built.

The Town Hall is a very fine building, the Durbar Hall, in which the city fathers meet, being one of the finest in India. In front is a statue of the late Queen Victoria.

In front of the statue, and standing in the middle of the main street of Delhi, the world-famous Chandni Chowk, is a clock tower with four faces and a chime of bells.

Delhi of today has gone far along the road of municipal management and amenities, and has studied the health and comfort of her citizens; but the age of British administration has been one of efficiency and utility rather than of beauty, and we have added no great building of architectural pretensions which can stand beside the great masterpieces bequeathed by our predecessors.

Delhi is again to take her stand as an Imperial city, and Phoenix-like from the ashes and ruins of past cities the piles are to rise which are to hold the Viceroy of our sovereign, and the councillors and machinery by which the great continent of India, with its millions of inhabitants, is governed.

The task of the town planners of the Imperial capital would appear to be to build not only a city which will set the high-water mark for India for the tide of municipal perfection and sanitation, but one which in stately beauty will also outrival both the massive grandeur of old Taglak's city and the inlaid magnificence of the Moghal palaces in the Fort.

*First-class roads comprise all the important thoroughfares within municipal limits. Second-class roads comprise all the narrow carriage ways linking up roads of the first class. Third-class roads comprise all narrow roads for wheeled traffic from roads of the second class, and leading chiefly to roads of the fourth class, which consist entirely of narrow roads, over which vehicular traffic is impossible. Most of the roads of the fourth class are paved with Delhi stone setts [blocks].

A Coal-Mine Explosion in the Imperial Mine, at Belle Valley, Ohio, caused the death of 15 men on May 17.

A Gasoline Explosion destroyed the plant of the Lapeer Gas & Electric Co., of Lapeer, Mich., on May 7.

The Bursting of a High-Pressure Cylinder of one of the engines of the German torpedo-boat "S. 148," while the vessel was participating in maneuvers near Helgoland, Germany, on May 14, killed four of the crew and seriously injured three others.

A Gas Explosion in a manhole at Fifth and Perry Sts., Dayton, Ohio, on May 7, caused serious injuries to five employees of the Dayton Gas Co. The men were in the manhole searching for a leak which had caused an explosion a few days previously. It is believed the gas was ignited by a spark caused by friction in removing a service-pipe connection.

An Explosion of Gasoline at the works of the Baker Castor Oil Co., Jersey City, N. J., caused the death of two employees and serious injuries to two others on May 13. Gasoline and naphtha were stored in five large tanks in a separate building from the other works. There is said to have been no fire or light in this building, and the cause of the explosion is unknown.

A Blast Containing 40,550 lb. of Powder was exploded at the quarries of the St. Louis Portland Cement Co., at Bellefontaine, Mo., on May 3. A safety zone of 1500 ft. from the quarry was established for spectators. The blast was successfully carried through without accident, although one of the mines failed to explode simultaneously with the others, and the explosives expert in charge came near losing his life in a premature examination of the results of the first explosion.

Windstorms in Nebraska, on May 14, killed eight persons in Seward and caused destruction to buildings over a strip one block wide and eight blocks long. The wind also did considerable damage in Tomaro and McCool Jc.

The Derailment of a Passenger Train on the Oregon-Washington R.R. & Navigation Co. tracks between Seattle, Wash., and Portland, Ore., near Lakeview, Wash., on May 12, caused the death of three passengers and a trainman. The train was running over a level track at a rate of about 65 miles per hour. The derailment is supposed to have been caused by the spreading of the rails.

A Typhoid Outbreak at Kenosha, Wis., is attributed to the water supply, which is from Lake Michigan. A hypochlorite plant is being installed. C. A. Jennings, of Chicago, is a charge.

Fire Destroyed a Grain Elevator of the Erie R.R. Co. at Buffalo, N. Y., on May 15. The elevator and some 700,000 bu. of grain were entirely consumed, and the total financial loss is estimated at $500,000. The fire spread across Buffalo Creek and destroyed 28 box cars loaded with grain on the Lehigh Valley R.R. tracks.

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Life Saving Rules for British ships are contained in the Board of Trade regulations issued on Jan. 23, and operative Mar. 1. According to press dispatch from London, England, these rules may be summarized as follows: British seagoing ships shall carry life-boats and life-saving appliances for all on board; steamers carrying passengers on short excursions between Apr. 1 and Oct. 31, during daylight and in fine weather must be supplied with boats for 70% of their total certified passenger capacity, and finally passenger steamers on inland waters must have boats sufficient for 40% of their total certified passenger capacity.

Riprapping the Gatun Dam, Panama Canal—The lake side of Gatun dam will be riprapped with hard rock for a distance of 10 ft. above and below the normal level of the water, 85 ft. above sea level. About 175,000 cu.yd. will be required for this purpose, and a steam-shovel has been set at work in one of the borrow pits near Monte Liria to procure this rock. Eearlier in the history of the canal work it was believed that the trap rock from the Bas Obispo dike of Culebra cut could be used for this purpose, and to that end a large amount of this rock was stored at Gatun. It soon developed, however, that it weathered rapidly and would not answer for the purpose, therefore it was used elsewhere in the work at Gatun. The rock from the borrow pit is hard and stands both air and water well. It will be dumped upon the south slope of the dam, without effort being made to place it regularly. Paving the slope would not be profitable, because the material in the dam is going through the process of shrinking, and the placed rock would not settle evenly.—["Canal Record."]

A Fire in the U. S. Geological Survey building at Washington, D. C., on Sunday afternoon, May 18, threatened for a while to destroy the building which houses all of the very valuable records of the Survey. The office is located in a rented building, the lower floors of which are given over to stores and storage rooms. The fire broke out in the cellar where was stored a great quantity of paper, and generated so much smoke and gas as to seriously discommode the efforts of the firemen, 25 of whom were overcome in fighting the fire. It was finally put under control, with a loss of about $40,000, $25,000 of which is charged to the Geological Survey for maps, atlases and stereotypes stored in the cellar. Fortunately the greater part of the very valuable records of the Survey were in the upper floors and were not damaged. This is the sixth fire in this building to threaten the Survey records.

Panama Canal Excavation during April totaled 2,653,995 cu.yd., a daily average of 102,077 cu.yd. for each of the 26 working days. The rainfall for the month was 1.89 in. The amount of concrete laid in April was 55,785 cu.yd., and 123,077 cu.yd. of fill was placed in dams.

The Municipal Freight Terminal Railway, mentioned in the article on the South Brooklyn freight-terminal improvements in "Engineering News," Mar. 7, 1912, p. 421, as a project is reported under way in the Broad of Estimate and Apportionment of the City of New York. Acting under authority conferred by the legislature in 1911, the city has adopted a plan providing for the construction of a municipal railroad extending along the entire Brooklyn water front from the Brooklyn Bridge south to 66th St. This road will tie together, for freight service, the various unconnected sections of water front and allow a free interchange of traffic between all points of this water front and provide for the assembling and distributing of freight cars at a central point for transshipment by various trunk lines. The territory to be occupied includes three important sections now distinct. First, the northern end from Brooklyn Bridge to the Atlantic basin forms one unit, the freight handling facilities for which are in the hands of the New York Dock Co.; this company has three unconnected sections of railroad in addition to its piers and warehouses. South from Atlantic basin to 28th St. is an undeveloped section with no railroad facilities, but which is adapted for manufacturing and industrial purposes with relatively cheap, unimproved water front. Here will be located one of the important terminals of the New York State Barge Canal now nearing completion. The third section extends south from 28th St. and is at present controlled by the Bush Terminal Co., which has seven large piers and a number of modern industrial buildings with an electric surface railroad connecting the upland plant with the docks and float bridges. At present it exchanges freight shipments with all of the railroads on a tonnage basis.

The city plan provides for the purchase of the railroad holdings of the New York Dock Co. and the Bush Terminal Co. The lines of the former would be rebuilt and connected to form a two-track main line from Brooklyn Bridge to the Atlantic basin. The rails would be on surface level, except for a short stretch of elevated line to avoid grade crossings at Atlantic and Hamilton Aves., two main traffic thoroughfares. New construction would be required south to a connection with the Bush company's tracks to 28th St. and 2nd Ave. As a part of this new construction would be a large classification yard, one-half mile long and 1800 ft. wide. Serving this yard would be eight float bridges.

The main line of this terminal road would continue through the classification yard and cross Gowanus Canal on a new bridge, probably of bascule type. South from the eastern side of the canal the tracks will run south over a private right-of-way 100 ft. west of Third Ave. To avoid crossing the present ferry entrance at grade the tracks would be carried on an elevated structure across the site of a proposed city market at 40th St. and brought back down to grade near 39th St. At the southern end of this municipal line a connection will be provided with the New York Connecting R.R., which is in course of construction between the New Haven and the Pennsylvania roads.

This municipal railroad will be constructed and owned by the city exclusively. At the present the city is negotiating a contract for operation by which all the trunk lines reaching the port of New York would unite in forming a corporation in which they would have equal stock interests. It is proposed to have this corporation lease the road at a fixed rental and assume the details of operation. The condemnation of land for the classification yard is under way and negotiations have been started with the Bush and New York Dock companies for their railway property.

PERSONALS

Mr. E. F. Harper has been appointed City Engineer of East St. Louis, Ill.

Mr. John W. Hoffman has resigned as General Manager of the Missouri, Oklahoma & Gulf Ry.

Mr. W. J. Hazeltine, of Bogota, N. J., has been appointed Assistant City Engineer of Mansfield, Ohio.

Mr. H. E. Myers has been appointed Superintendent of Shops of the Lehigh Valley R.R., at Packerton, Penn.

Mr. E. U. Smith has been appointed Bridge Engineer of the Wheeling & Lake Erie R.R. at Cleveland, Ohio.

Mr. C. M. Nye has been appointed Principal Assistant Engineer of the Great Northern Ry., at St. Paul, Minn.

Mr. C. L. Raymond, of the city engineering department of Rochester, N. Y., has been appointed Assistant City Engineer in charge of flood protection.

Mr. William Ziehnert, formerly City Engineer of Belleville, Ill., has been appointed Chief Engineer for the construction of the State Hospital at Alton.

Mr. G. H. Friend has been appointed Assistant Chief Engineer of the Western Maryland Ry., and the office of Principal Assistant Engineer has been abolished.

Mr. A. T. Enlow, former Manager of Sales of the Stark Rolling Mill Co., Canton, Ohio, has resigned to become associated with the Pedlar Metal Roofing Co., Oshawa, Ont.

Mr. T. J. Burke, formerly Divison Engineer of the Lehigh Valley R.R. at Auburn, N. Y., has been transferred to Hazleton, Penn., succeeding Mr. J. A. Zehner, resigned.

Mr. Daniel Breck has been elected Vice-President of the Missouri, Oklahoma & Gulf Ry., in charge of operation and traffic, succeeding Mr. J. W. Hoffman, General Manager.

Mr. Albert W. Bee, Jr., formerly Engineer with D. X. Murphy & Bro., Louisville, Ky., has accepted a position in the engineering department of the Leonard Construction Co., Chicago, Ill.

Mr. R. J. Windrow, of the Agricultural and Mechanical College of Texas, has been appointed Road Superintendent of McLennan County, Texas, at a salary of $2500 per annum.

Mr. Ernest McGeorge, formerly with J. Milton Dyer, Consulting Engineer, of Cleveland, Ohio, has opened an office in the Leader Bldg., Cleveland, for the general practice of engineering.

Mr. H. E. Barnes, Jun. Am. Soc. C. E., has resigned as Assistant Engineer, Board of Water Supply, City of New York, to accept a position with the Standard Engineering Co., Cleveland, Ohio.

Mr. J. H. Clark, recently Assistant Superintendent of floating equipment of the Baltimore & Ohio R.R., New York City, has been promoted to be Superintendent to succeed the late Walter Ancker.

Mr. C. E. Segrest, formerly General Foreman of Shops of the Louisville & Nashville R.R., at Anniston, Ala., has been promoted to be General Mechanical Inspector, with headquarters at Louisville, Ky.

Mr. John S. Kennedy, Secretary of the Public Service Commission of New York, Second District, since its organization in 1907, has resigned to accept a position with the New York Telephone Co., New York City.

Mr. R. J. Sullivan, formerly Division Superintendent of the Missouri, Kansas & Texas Ry., at Wichita Falls, Tex., has resigned to become General Superintendent of the Apalachicola & Northern R.R., at Port St. Joe. Fla.

Mr. H. W. Stanley, formerly Assistant General Manager of the Seaboard Air Line Ry., has been promoted to be General Manager. Mr. Stanley was born in 1874, and entered the railway service as a telegraph operator in 1890.

Mr. M. C. Blanchard, Division Engineer of the Atchison, Topeka & Santa Fé Ry., at Topeka, Kan., has been promoted to be Office Engineer at Topeka, succeeding Mr. K. B. Duncan, promoted as noted elsewhere in these columns.

Mr. E. D. Jackson, formerly Assistant Engineer of the Baltimore & Ohio R.R., at Baltimore, Md., has been appointed Division Engineer of Maintenance-of-Way, with headquarters at Philadelphia, Penn., succeeding Mr. C. C. Cook, transferred.

Mr. Alexander Legge, formerly Assistant General Manager of the International Harvester Co., of Chicago, Ill. has been

promoted to be General Manager, succeeding Mr. C. S. Funk, resigned to become General Manager of the Rumely Co., La Porte, Ind.

Mr. G. L. Mattice, M. Can. Soc. C. E., recently Assistant District Engineer of the National Transcontinental Ry. of Canada, has been appointed District Engineer of the North Railway Co., with headquarters in the Canadian Express Bldg., Montreal, Que.

Mr. E. F. Kearney, formerly General Superintendent of Transportation of the Missouri Pacific Ry., has been elected Vice-President in charge of operation of the Texas & Pacific and International & Great Northern Rys., with headquarters at New Orleans, La.

Mr. B. M. Hall, Jr., of the firm of Hall Bros., Consulting Engineers, Atlanta, Ga., has been appointed Assistant Hydrographer for the State Engineering Commission of Florida, recently appointed to investigate and report upon the reclamation of the Everglades swamp by drainage.

Mr. Charles F. Kerrigan, a Brooklyn, N. Y., newspaper man, has been appointed Secretary of the newly created Commission of Efficiency and Economy of New York, at a salary of $4000 per annum. The annual salary budget of the new department to date for four men amounts to $29,000.

Mr. K. B. Duncan, formerly Office Engineer of the Atchison, Topeka & Santa Fé Ry., at Topeka, Kan., has been promoted to be Assistant Chief Engineer of the Gulf, Colorado & Santa Fé Ry., at Galveston, Tex., succeeding Mr. R. A. Rutledge, promoted, as noted in our issue of Apr. 24.

Mr. W. H. Averell, formerly Assistant General Superintendent of the Baltimore & Ohio R.R., at Pittsburgh, Penn., has been transferred to the same position at New York City, where he will also become General Superintendent of the Staten Island Ry. and the Staten Island Rapid Transit Ry.

Mr. John Mitchell, of Mount Vernon, N. Y., former President of the United Mine Workers of America, has been appointed State Labor Commissioner of New York, at a salary of $8000 per annum. Mr. John Williams, until recently at the head of the department, has been appointed Deputy Commissioner, at a salary of $5000 per annum.

Mr. L. J. Putnam has been appointed Principal Assistant Engineer of the Chicago & Northwestern Ry., and Mr. M. E. Thomas succeeds him as Division Engineer at Boone, Iowa. Mr. W. J. Jackson has been transferred to Winona, Minn., as Division Engineer, in place of Mr. Thomas, and Mr. Lee Jutton has been appointed Division Engineer with office at Madison, Wis.

Mr. Gilbert C. White, Assoc. M. Am. Soc. C. E., of Charlotte, N. C., Mr. Benjamin M. Hall, M. Am. Soc. C. E., of Atlanta, Ga., and Judge Thomas J. Shaw, of Greensboro, N. C., as a board of arbitration, have recently appraised the Wake Water Co.'s plant at Raleigh, N. C., at $250,000, and the city has agreed to take over the water-works within 30 days from May 3.

Mr. William Downie, General Superintendent of the Atlantic division of the Canadian Pacific Ry., at St. John, N. B., has been granted a year's leave of absence. Mr. and Mrs. Downie will spend their vacation in Vancouver, B. C., and in Europe. Mr. H. C. Grout, Assistant General Superintendent will be Acting General Superintendent during Mr. Downie's absence.

Mr. Harold Parker, M. Am. Soc. C. E., former Chairman of the Massachusetts Highway Commission, of Worcester, Mass., and Mr. W. D. Washington, of New York City, have been appointed by the Commissioner of Highways of New York State, Mr. John N. Carlisle, as two members of an advisory board of engineers to make a thorough investigation of the highway problems of the state.

Mr. George D. Snyder, M. Am. Soc. C. E., M. Inst. C. E., of Jacobs & Davies, Inc., Consulting Engineers, New York City, has been awarded the George Stevenson Gold Medal of the Institution of Civil Engineers of Great Britain, for his paper entitled "Notes on City Passenger Transportation in the United States." Mr. Snyder was formerly Principal Assistant Engineer of the Hudson & Manhattan R.R. and is now a member and director of the firm of Jacobs & Davies, Inc.

Messrs. Julian N. Walton, formerly Chief Electrical Engineer of the Bradley Contracting Co., New York City, and Frederick M. Beer, formerly Assistant Civil Engineer of the company, have formed a partnership under the firm name of Walton & Beer, 1166 Bedford Ave., Brooklyn, N. Y., for the general practice of engineering, specializing, however, in efficiency engineering in connection with public-works contracts.

Messrs. Leonard Metcalf and H. P. Eddy, M.'s Am. Soc. C. E., Consulting Engineers, Boston, Mass., announce that they have taken into partnership Mr. Charles W. Sherman, M. Am. Soc. C. E., recently Principal Assistant Engineer of the firm, Mr. Wm. T. Barnes, M. Am. Soc. C. E., Engineer in charge of the Chicago office of the firm, and Mr. Almon L. Fales, until recently Superintendent of the Worcester, Mass., sewage treatment works.

Mr. B. C. Collier, M. Am. Soc. C. E., Resident Engineer for H. S. Kerbaugh, Inc., on the construction of the Kensico dam of the New York City water-supply, has resigned to accept the position of Engineer and General Superintendent for the Hassam Paving Co., of Worcester, Mass., and the Parker-Hassam Paving Co., of New York City. He will have supervision of all work outside of New England and New Jersey, with headquarters at 7 East 42d St., New York City.

Mr. Oscar S. Bowen, M. Am. Soc. C. E., Resident Engineer of the Great Northern Ry., at Spokane, Wash., has been transferred to the same position at Seattle, Wash., succeeding Mr. R. L. Beaulieu. Mr. Bowen will have jurisdiction of the Western district and Mr. P. S. Herrin, Resident Engineer at Minot, N. D., has had his jurisdiction extended to cover the Montana and Butte divisions and the Central district. The position of Resident Engineer at Spokane has been abolished.

Prof. H. O. Garman, Assoc. M. Am. Soc. C. E., of the department of civil engineering, Purdue University, has been appointed Chief Engineer of the newly created Public Utility Commission of Indiana. Prof. Garman was Consulting Engineer of the Railroad Commission from 1907 until it was recently superseded by the Public Utilities Commission. Prof. Garman graduated from Purdue University in 1902, and has ever since been associated with the faculty of civil engineering.

Mr. James E. Allison, member and Chief Engineer of the St. Louis, Mo., Public Service Commission has resigned to engage in private practice as a Consulting Engineer, specializing in public service valuation work and the examination of securities. Mr. Allison is a graduate of Harvard University. He has been Chief Engineer of the St. Louis Public Service Commission since 1909, and during the past four years has had charge of the valuation of public utility properties representing a total capitalization of $170,000,000.

Prof. C. J. Tilden, Assoc. M. Am. Soc. C. E., Consulting Engineer and Professor of engineering mechanics at the University of Michigan, has resigned to become Professor and head of the new department of civil engineering at Johns Hopkins University, Baltimore, Md. Prof. Tilden graduated from Harvard University in 1896 and for several years was structural draftsman and Assistant Engineer with the New York City Rapid Transit Commission. He was appointed Instructor in civil engineering at Cornell University in 1904, and the following year went to the University of Michigan as Assistant Professor of civil engineering.

Mr. N. E. Brooks, M. Can. Soc. C. E., formerly Division Engineer of the Alberta division of the Canadian Pacific Ry., at Calgary, Alta., and several times Acting General Superintendent of the division, has been promoted to be Engineer of Maintenance-of-way of the Western lines. Mr. Brooks was born at Sherbrooke, Que., in 1866. His engineering experience began in 1887 as a chainman with the Canadian Pacific Ry. Later he was promoted to be rodman and Resident Engineer on construction of the Atlantic & Northwest branch. From 1889 to 1893 he was transitman and Resident Engineer on surveys and construction of the Calgary & Edmonton and MacLeod & Crows Nest branches. For the following 10 years he was representative of the bondholders in connection with the Calgary & Edmonton branch, with headquarters at Calgary. In 1903 he was appointed Division Engineer of the Western division, and in 1910 he was appointed to the same position on the Alberta division.

Mr. William V. S. Thorne, formerly Director of Purchases of the Union Pacific R.R., with headquarters in New York City, has been elected Vice-President of the Union Pacific R.R., the Oregon Short Line R.R., and the Oregon-Washington R.R. & Navigation Co., at New York City. Mr. Thorne is a graduate of Sheffield Scientific School, Yale University, class of 1885, and for several years he was engaged in railway location and construction work with the engineering department of the St. Paul, Minneapolis & Manitoba Ry. He was transferred to the operating department as clerk to the General Manager. Later he was Assistant Purchasing Agent, Shop Superintendent and Division Superintendent. From 1895 to 1902 he was Vice-President and General Manager of the Pennsylvania Coal Co., Vice-President of the Erie & Wyoming Valley R.R. and President of the Delaware Valley & Kingston Ry. Mr. Thorne first became associated with the Union and Southern Pacific Rys. in 1902 as Assistant to the late E. H. Harriman.

OBITUARY

Nicholas Engel, at one time City Engineer of Milwaukee, Wis., died May 3, aged 83 years.

James R. Huber, Western Sales Representative of the Lumen Bearing Co., of Buffalo, N. Y., died from pneumonia at his home in Detroit, Mich., May 8.

Hugh Reid, senior member of the firm of Reid & Brown, structural steel and iron workers, of Toronto, Ont., died at his home in that city May 11.

Rudolph Francis Bartle, map engraver for the International Waterways Commission, died at Buffalo, N. Y., May 15. He was 45 years old and one of the foremost engravers in the federal employ.

Peter P. Johnson, a well known railway contractor of Spokane, Wash., died May 1, aged 67 years. He was engaged in the construction of a branch of the Great Northern Ry. from Bluestem to Peach. He was a native of Sweden.

Charles H. Pindell, Assistant to the President of the Warren Bros. Co., of Boston, Mass., died May 13, from heart trouble after an illness of only two days. He was 32 years old and well known to a host of municipal and highway engineers.

Clarence Deming, for many years an editorial writer with the "Railway Age-Gazette," died May 8. He was born at Litchfield, Conn., and graduated from Yale University in 1872. For several years he was a member of the staff of the New York "Evening Post."

Robert Wilson Sayles, M. Am. Soc. C. E., Principal Assistant Engineer with Chas. W. Leavitt, Jr., M. Am. Soc. C. E., New York City, died in Montclair, N. J., May 7. He was born in Chicago, Ill., in 1873 and attended Cornell University. In 1895 he left his college work to become an assistant with James Owen, M. Am. Soc. C. E., Consulting Engineer, of Newark, N. J. For a short time later he was Assistant Engineer for the Passaic Valley Sewerage Commission. He had been employed with Mr. Leavitt for over 15 years.

Henry William Vehrenkamp, M. Am. Soc. C. E., Chief Engineer of the Ferro Concrete Construction Co., of Cincinnati, Ohio, died Apr. 26. He was 36 years old, a native of Cincinnati and a graduate of the University of Cincinnati, class of 1899. He served for a time in the United States Coast and Geodetic Survey, as instructor at his alma mater and as inspector on the construction of new Cincinnati water-works. After some experience in structural steel work with the Fort Pitt Bridge Co., of Pittsburgh, Penn., he returned to the Cincinnati water-works as a structural designer. He was first employed by the Ferro Concrete Construction Co., in 1903, and two years later he was made Chief Engineer.

Stephen Dudley Field, F. Am. Inst. E. E., inventor of electrical devices, died at his home in Stockbridge, Mass., May 18, aged 68 years. He was born in Stockbridge and was a nephew of Cyrus W. Field, famous for having laid the first transatlantic submarine cable. Stephen Dudley Field invented a multiple call telegraph box in 1874 and an electric elevator in 1878; he was a pioneer experimenter and inventor of electric railway equipment, and in 1879 he made the first application of dynamo machines to telegraphy. The following year he invented a dynamo quadruplex telegraph, in 1884 a fast stock ticker, and in 1909 made the first application of quadruplex telegraphy to submarine cables on the line between Key West, Fla., and Havana, Cuba. Mr. Field was also a member of the Institution of Electrical Engineers of Great Britain.

John Saxby, M. Inst. M. E., inventor of the interlocking railway switch and signal, died recently at his home in Hassocks, near Hayward's Heath, England. He was born at Brighton in 1821, and began his career as a carpenter's apprentice. His attention was early drawn to the frequency of railway accidents and he took upon himself the problem of bettering the operating facilities of railways. He soon recognized a common cause of accidents in carelessness from independent operation of switches and governing signals. Mr. Saxby's first patent covering an interlocked switch and signal was obtained in 1856. The same year the signal installation at Bricklayers' Arms Junction on the Southastern Ry. was enlarged and reconstructed according to Mr. Saxby's system, the frame there controlling eight signals and six switches. The interlocking plants now in universal use are direct developments of this first installation. For 22 years Mr. Saxby was employed by the London, Brighton & South Coast Ry., and during these years he made many improvements in his apparatus. The success of his system was such that he went into business on his own account in the manufacture of switch and signal equipment under the firm name of Saxby & Farmer. Besides large works at Kilburn, in England, other plants were established in Belgium and France.

Horace G. Burt, former President of the Union Pacific R.R. and at one time Chief Engineer of the Chicago & Northwestern Ry., died May 19, at his home in Chicago, Ill. In April, 1911, Mr. Burt was appointed Chief Engineer for a committee composed of representatives from the leading commercial associations of Chicago to investigate the necessity of the electrification of the railways entering the city. Mr. Burt was born in January, 1849. He graduated from the Terre Haute, Ind., public high school in 1867 and from the University of Michigan in 1878. Before his graduation he had had several years' experience in railway location and construction. From 1873 to 1881 he was in the engineering department of the Chicago & Northwestern Ry., and then entered the operating department as Superintendent of the Northern Iowa division. In October, 1887, he was appointed Chief Engineer, and a year later left the Chicago & Northwestern Ry. to become General Manager of the Fremont, Elkhorn & Missouri Valley R.R. In 1896 he became General Manager of the Chicago, St. Paul, Minneapolis & Omaha Ry., and later in the same year he was elected Third Vice-President of the Chicago & Northwestern Ry. in charge of traffic. From Jan. 1, 1898 to Jan. 1, 1904, he was President of the Union Pacific R.R. After a trip around the world he returned to Chicago and again took up his engineering work as a consulting engineer. In 1909 he was Receiver for the Chicago Great Western Ry., and since 1911 had been Chief Engineer for the Chicago Association of Commerce smoke abatement committee.

ENGINEERING SOCIETIES

COMING MEETINGS

MASTER BOILER MAKERS' ASSOCIATION.
May 26-29. Annual meeting at Chicago, Ill. Secy., Harry V. Vought, 96 Liberty St., New York City.

NATIONAL DISTRICT HEATING ASSOCIATION.
May 27-29. Annual convention at Indianapolis, Ind. Secy., D. L. Gaskill, Greenville, Ohio.

NATIONAL ELECTRIC LIGHT ASSOCIATION.
June 2-6. Annual convention at Chicago, Ill. Secy., T. C. Martin, 29 W. 39th St, New York City.

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.
June 11-13. Annual convention at Atlantic City, N. J. Secy., J. W. Taylor, Old Colony Bldg., Chicago, Ill.

ASSOCIATION OF RAILWAY ELECTRICAL ENGINEERS.
June 16. Semi-annual meeting at Atlantic City, N. J. Secy., Jos. A. Andreucetti, Room 411, C. & N. W. Ter, Sta., Chicago, Ill.

MASTER CAR BUILDERS' ASSOCIATION.
June 16-18. Annual convention at Atlantic City, N. J. Secy., J. W. Taylor, 390 Old Colony Bldg., Chicago, Ill.

TRAIN DISPATCHERS ASSOCIATION OF AMERICA.
June 17-19. Annual meeting at Los Angeles, Calif. Secy., John F. Mackie, 7122 Stewart Ave., Chicago, Ill.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
June 17-20. Annual convention at Ottawa, Ont. Secy. Charles Warren Hunt, 220 W. 57th St., New York City.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.
June 23-26. Annual convention at Cooperstown, N. Y. Secy., F. L. Hutchinson, 33 W. 39th. St., New York City.

AMERICAN WATER-WORKS ASSOCIATION.
June 23-28. Annual meeting at Minneapolis, Minn. Secy., J. M. Diven, Troy, N. Y.

PERMANENT INTERNATIONAL ASSOCIATION OF ROAD CONGRESS.
June 23-28. Congress at London, England. Secy., W. Rees Jeffreys, Queen Anne's Chambers, Broadway, Westminister, London, S. W.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION.
June 24-26. Annual meeting at Minneapolis, Minn. Secy., H. H. Norris, Cornell University, Ithaca, N. Y.

AMERICAN SOCIETY FOR TESTING MATERIALS.
June 24-28. Annual convention at Atlantic City, N. J. Secy., Edgar Marburg, University of Pennsylvania, Philadelphia, Penn.

CANADIAN ELECTRICAL ASSOCIATION.
June 25-27. Annual convention at Toronto, Ont. Secy., T. S. Young, 220 King St. West, Toronto, Ont.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS.
June 25-28. Semi-annual meeting at Boston, Mass. Secy., J. C. Olsen, Polytechnic Institute, Brooklyn, N. Y.

American Society of Heating and Ventilating Engineers—The report of the committee appointed last year to formulate standards for ventilation of moving-picture theaters, presented at the last annual meeting of the society, has been approved by a letter ballot of the members. The report has been printed and the society will be glad to furnish copies gratis to all engineers, boards of health, town councils, ventilation inspectors and others interested. The secretary is E. A. Scott, 29 W. 39th St., New York City.